BNL-83294-1995

REPORT ON THE STUDY OF RADIATION DAMAGE IN CaF_2 AND MgF_2 WINDOWS FOR EXCIMER LASER APPLICATIONS

Research performed for CRADA No. BNL-C-94-26 between

Optovac
North Brookfield, MA.

and

Brookhaven National Laboratory
Upton, N.Y.

September 20, 1995

1. INTRODUCTION

This report summarizes the work done by Brookhaven National Lab and Optovac on CRADA No. BNL-C-94-26, the purpose of which was to study radiation damage in certain types of fluoride crystals. Because of the important commercial aspect of developing high radiation resistant CaF_2 and MgF_2 for optical windows for 193 nm ArF excimer lasers, which are used in laser eye surgery, micromachining, and could play a major role in the next generation of UV lithography, this study concentrated mainly on these two materials. Optovac manufactures CaF_2 and MgF_2 polished laser windows for commercial use. Over the past several years, based on the expected increased use of ArF excimer lasers outside the research community, Optovac has grown ingots and fabricated test samples using raw materials from various sources in order to evaluate their resistance to color center formation and failure over time when subjected to pulsed 193 nm laser light. As a result, a baseline on the performance of these materials has been established which serves as a guide for further improvements with respect to their radiation resistance.

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The purpose of the study was to search for a correlation in the level and type of radiation damage produced in CaF_2 and MgF_2 windows by 193 nm excimer laser light with damage produced by ^{60}Co gamma rays. If such a correlation can be established, as the data obtained in this study indicates, it will be possible to study radiation damage in these materials using ^{60}Co in a much more efficient and cost effective way. This would eliminate the need for using an excimer laser to study the damage, which can require many laser pulses over a considerable period of time, and allow a much more rapid and detailed study of many types of damage effects. It will also allow for a rapid and inexpensive way of selecting radiation hard material before it is fabricated into expensive optical components. In addition, it will lead to a better understanding of the damage process itself, which will hopefully result in improved and more radiation hard materials.

2. SAMPLE PREPARATION

Optovac grows a number of fluoride crystals such as CaF_2, MgF_2, SrF_2, BaF_2 and LiF by the Bridgeman-Stockbarger method as commercial production processes. Although there are some variations in the details, the basic method is the same for all of the CaF_2 and MgF_2 samples prepared for this study. The raw material is first melted in a crucible inside the furnace. Crystal growth is accomplished by lowering the crucible out of the hot zone such that the material solidifies from the bottom up to form a crystal. Fluorides of good optical quality require a growth environment of very low moisture and oxygen, which is accomplished in part by growth under vacuum conditions using a diffusion pump. The evacuable growth chamber consists of a steel bell jar and a base plate fitted with sealed throughputs for graphite electrodes, and a cylindrical slotted graphite heating element that is supported by graphite electrode pedestals. During a typical growth, the molten ingot material is held inside a graphite crucible which rests on a support system containing a movable pedestal that can be raised or lowered. The temperature within the furnace is adjusted so that the bottom of the crucible is located in a temperature gradient such that the upper part of the seed and all of the material above it is melted. Seeded growth is accomplished by slowly lowering the crucible such that the crystal is grown by moving the

the molten ingot through the solid-liquid interface. Generally, all crystals are annealed in the furnace after the growth process is complete, or later in a furnace designed to reduce strain within the crystal ingot.

Sample	Size	RM Source	Pretreatment
CaF_2 Set SA92059			
1446	50.8 × 10.0 mm	A	1
1447 (447)	50.8 × 10.0 mm	A	2
1448c (48C)	50.8 × 10.0 mm	A	3
1T (31T)	50.8 × 10.0 mm	A	1
1B (31B)	50.8 × 10.0 mm	A	1
2T (72T)	50.8 × 10.0 mm	A	4
3T (13T)	50.8 × 10.0 mm	B	5
3B (13B)	50.8 × 10.0 mm	B	5
4T (54T)	50.8 × 10.0 mm	C	5
4B (54B)	50.8 × 10.0 mm	C	5
CaF_2 Set SA940			
012A	50.8 × 9.53 mm	C	6
14	50.8 × 9.53 mm	C	6
16	50.8 × 9.53 mm	D	6
17A	50.8 × 9.53 mm	D	6
MgF_2 Set SA940			
04A	36.0 × 10.0 mm	C	6
05A	36.0 × 10.0 mm	A	1
06A	36.0 × 10.0 mm	E	6
07A	36.0 × 10.0 mm	F	1
10A	36.0 × 10.0 mm	E	6
11A	36.0 × 10.0 mm	G Blank	

Table 1. CaF_2 and MgF_2 samples prepared for excimer laser and gamma ray irradiation study.

Twenty samples of polished CaF_2 and MgF_2 were prepared by Optovac for this study and are listed in Table 1. The RM source column refers to the manufacturer and grade of the raw material. The Pretreatment column represents a treatment of the raw material

prior to or during the growth process which is considered proprietary by Optovac at this time. In several cases, the same letter designation is used for both the CaF_2 and MgF_2, which indicates the same manufacturer and grade for both. The samples were either identical to the ones used for the excimer laser damage measurements, or duplicate samples from the same ingots used in those tests. The fourteen CaF_2 samples represent eleven different ingots grown and fabricated at Optovac, and the six MgF_2 samples represent five different ingots grown at Optovac and one sample from a non-Optovac source. Raw materials from several sources were tested in order to judge the results related to factors outside the production process. Sample 11A represents a crystal blank purchased from another company. All samples, including sample 11A, were polished with the standard Optovac process.

3. RESULTS FROM LASER DAMAGE

Samples grown at Optovac were initially exposed to excimer laser radiation at the MIT Lincoln Laboratory. The laser used was a ArF laser which had an energy output of 100 mJ/cm^2 and a repetition rate of 150 Hz. Most samples were exposed for 1 or 2 $\times 10^6$ pulses, and some samples were exposed for up to 8 $\times 10^6$ pulses. The area exposed to the laser beam was typically 0.5×1.0 cm^2, which meant that most of the sample was left unexposed, and therefore undamaged, by the laser tests. It was therefore possible to study both the laser damaged regions and the undamaged regions of each sample in subsequent gamma ray damage measurements.

It is difficult to estimate the actual amount of energy absorbed by the windows for these exposures since the total absorbance at 193 nm is very small, and in fact, very difficult to measure accurately with the spectrophotometers which were used for this study. However, it is possible to estimate an upper limit on the dose based on reasonable limits in the measured absorbance. The energy of 100 mJ/cm^2 corresponds to 6.2×10^{17} eV/cm^2, or 6.2×10^{11} $MeV/cm^2/pulse$. Assuming a beam spot of $\sim$ 0.5×1.0 cm^2, this corresponds to $\sim$ 3.1×10^{11} MeV/pulse. For a window thickness of 1 cm, the irradiated volume is then 0.5 cm^3. Multiplying this by the density of CaF_2 (3.18 g/cm^3) gives an irradiated

mass of $\sim$ 1.6 g. This gives a dose of 3.1×10^{11}MeV/.0016 kg = 1.9×10^{14} MeV/kg. Given that 1 Gy = 6.24×10^{12} MeV/kg, this corresponds to $\sim$ 31 Gy/pulse, if all of the energy were absorbed. Assuming an absorbance of $\sim$ .01, this would correspond to $\sim$ 0.3 Gy/pulse. Hence, the absorbed dose for 10^6 pulses would be $\sim$ 0.3×10^6 Gy = 30 Mrad. Therefore, the total absorbed dose in the samples which were exposed to the excimer laser in these tests could be quite large. However, the total absorbance at 193 nm could be significantly less than 0.01, in which case the total absorbed dose would be correspondingly much smaller. In addition, damage due to color center formation often results from ionization, which requires an energy sufficient to produce an electron-hole pair in the material. For 193 nm photons, corresponding to an energy of 6.4 eV, this requires the simultaneous absorption of two photons, which is greatly suppressed relative to single photon absorption. It is therefore likely that for a given amount of energy deposited in the material, the 193 nm laser light is considerably less efficient than gamma ray radiation for producing color centers.

The optical absorbance as a function of wavelength for all samples were measured before and after exposure to the excimer laser at MIT using a Hewlett-Packard diode array spectrometer. This is a single beam instrument which requires measurements with and without the sample in place. The laser damage measurements were carried out between December 1992 and May 1994, while the gamma ray irradiations were done in early 1995. Therefore, a considerable amount of time passed by between the two sets of measurements, which allowed a certain amount of recovery to take place before the gamma ray measurements were started. This effect was noted when the samples were remeasured at BNL prior to their exposure to gamma rays, as discussed below.

4. RESULTS FROM GAMMA RAY DAMAGE

The previously laser damaged samples were sent to Brookhaven where their optical absorbance was measured again in both the damaged and undamaged region using a Hitachi 3210 dual beam spectrophotometer. In general, good agreement was found between the measurements made at MIT and at BNL, taking into account the recovery which occurred between the two measurements. This can be seen from the absorbance data for each sample measured at MIT and BNL given in Appendix A. Recovery was observed in both CaF_2 and MgF_2, but in general, the CaF_2 showed more recovery than the MgF_2.

The gamma ray irradiations were carried out at the ^{60}Co Gamma Ray Irradiation Facility (GRIF) at Brookhaven National Lab. This facility consists of a 20K Ci ^{60}Co source housed inside a building containing a large UV-VIS spectrophotometer which is capable of measuring the change in optical absorbance of samples before, *during*, and after irradiation. However, in the tests carried out in this study, the facility was only used as a radiation source for irradiating samples at a dose rate of 3.2 - 4.0 $\times$ 10^4 rad/hour. The optical absorbance measurements were made on the Hitachi 3210 spectrophotometer in a separate lab within one hour after irradiation.

An initial series of tests was done for both the CaF_2 and MgF_2 samples to determine what level of exposure would be appropriate to see the effects of gamma ray damage in each of these materials. Figures 1-4 show the change in absorbance in the CaF_2 and MgF_2 samples as a function of gamma ray dose. It is clear that the CaF_2 sample shows damage at a fairly low dose ($\sim$ few krad), while the MgF_2 sample shows much less damage, as measured in the undamaged region, even up to a dose of 100 Krad. For the MgF_2, the damage appears to saturate, as is evident in the previously damaged region, while the CaF_2 does not saturate, at least up to 100 Krad. It is also clear that very similar absorption bands are produced by both the excimer laser and gamma ray radiation in both materials. Since it is only necessary to produce gamma ray damage at a fairly low level in order to study the correlation with the laser damage, it was decided to expose all remaining CaF_2 samples to a dose of 1 krad. Because the MgF_2 samples damaged much less, it was decided to use a dose of 1 Mrad for the MgF_2 for the correlation studies.

5. CORRELATION RESULTS

It is clear from the data given in Appendix A that the radiation induced absorption in both the the CaF_2 and MgF_2 samples are very similar for both the excimer laser and the gamma ray irradiations. In general, two main regions of absorption bands appear in CaF_2, one with two prominent peaks between 300-400 nm, and another single peak around 600 nm. However, not all samples show the same band structure, and there is a substantial sample to sample variation. In the MgF_2, there is a very distinct peak produced at 256 nm in all samples, and an additional peak appears $\sim$ 370 nm in some samples but not in others. Nevertheless, the general structure of the induced absorbance in both materials is very similar for both types of radiation.

Since the ultimate application of the materials used in this study is for optical components in 193 excimer lasers, it is clearly of interest to study the correlation between the optical absorbance induced at 193 nm by the excimer laser with the absorbance produced by gamma rays at the same wavelength. Although the absorbance at 193 was always measured for each sample, the absorbance at 200 nm can be measured with better accuracy and is indicative of the absorbance produced in the same wavelength region. It is also possible that a correlation exists between the absorbance induced by the laser in the 190-200 nm region and other absorption bands produced at other wavelengths. This is particularly true for MgF_2 where there is a prominent band at 256 nm which is induced by both types of radiation. One can also look at the maximum induced absorbance at *any* wavelength, or take the integral of the induced absorbance between a particular set of wavelengths (e.g., 190-800 nm) as a measure of the *total* induced absorbance in the sample. We have therefore defined the following set of quantities used in the correlation study:

- *laser damage 193* - laser induced absorbance at 193 nm.
- *laser damage 256* - laser induced absorbance at 256 nm (MgF_2 only).
- *laser maximum induced* - maximum laser induced absorbance at any wavelength between 190 and 800 nm.
- *Co-60 induced 193* - ^{60}Co induced damage at 193 nm.
- *Co-60 induced 200* - ^{60}Co induced damage at 200 nm.

- *Co-60 induced 256* - ^{60}Co induced damage at 256 nm (MgF_2 only).
- *Co-60 maximum induced* - maximum ^{60}Co induced absorbance at any wavelength between 190 and 800 nm.
- *Co-60 sum induced* - integral of ^{60}Co induced absorbance between 190 and 800 nm.

Figures 5-10 show the correlations observed in thirteen CaF_2 samples (each indicated by the labels on the points) which were exposed to 2×10^6 laser pulses and 1 krad of ^{60}Co radiation. Figures 5 shows simply the self correlation between the laser induced damage at 193 nm and the maximum laser damage. Figure 6 shows the same self correlation for the ^{60}Co maximum induced and sum induced damage. Figures 7-10 show the correlation between the laser 193, laser maximum induced, ^{60}Co sum and ^{60}Co maximum induced damage. The ^{60}Co induced absorption was measured through the previously undamaged region of the sample (i.e., a region of the sample which was *not* exposed to the laser). It is clear from Figures 7-10 that a correlation *does exist* between the two sets of measurements. The least damaged sample for both the excimer laser and gamma ray exposures was sample 17, while the sample which damaged the most was sample 13B. Sample 014 appears to deviate from the trend given by the others, but the overall correlation is clear.

Figures 11-17 give the correlation plots for six MgF_2 samples (each again indicated by the labels on the points) which were exposed to 2×10^6 laser pulses and 1 Mrad of ^{60}Co radiation. In these figures, the ^{60}Co absorbance was measured through the previously undamaged region. Figures 11 and 12 show the self correlation data, while figures 13-17 give the correlation between the laser damage and the gamma ray damage. While it is clear that the worst sample (sample 004) shows the maximum damage in both cases, the correlation for the samples which damage less is not as clear as in the case of CaF_2.

Measurements after ^{60}Co irradiation were also made on the MgF_2 samples through previously damage region, i.e., the same region which was initially exposed to the laser. Figures 18-22 show plots similar to Figures 13-17 through the previously damage region. Again, the sample with the maximum damage is clearly identified in both cases, but the correlation between the other samples is less evident.

6. CONCLUSIONS

This study has investigated radiation damage produced in CaF_2 and MgF_2 optical windows produced by a 193 nm ArF excimer laser and ^{60}Co gamma rays. The general structure of the radiation induced absorption bands is very similar in both materials for both types of radiation. In CaF_2, several absorption bands are observed in the 300-400 nm region, and another at $\sim$ 600 nm. In MgF_2, a strong absorption peak is observed at 256 nm, and a smaller secondary peak is observed at $\sim$ 370 nm in some samples.

In the case of CaF_2, a clear correlation is observed between the laser induced damage and the gamma ray induced damage. This correlation can be seen in a number of variables which measure the degree of laser or gamma ray induced damage. Within the limits of the small statistical sample measured, some degree of correlation is also observed in MgF_2. However, for samples which show only small amounts of damage for both types of radiation, the correlation is less apparent in MgF_2 than in CaF_2.

This study was intended as a preliminary investigation into the effects of radiation damage in both CaF_2 and MgF_2 optical materials. The experiments conducted between Optovac, MIT and BNL were not closely coordinated due to fact these were initially separate projects which were carried out independently of each other. Given the rather clear indication of a correlation observed between the damage produced by the two mechanisms, it appears to be extremely worthwhile to pursue these studies in a more coordinated way. As stated earlier, this could lead to a simple and cost effective means of identifying radiation hard material before it is fabricated into expensive optical components, and could further lead to better and improved materials for the next generation UV lithography. We feel that this work supports this claim, and that additional effort should be devoted to this area in the future.

Figure 1

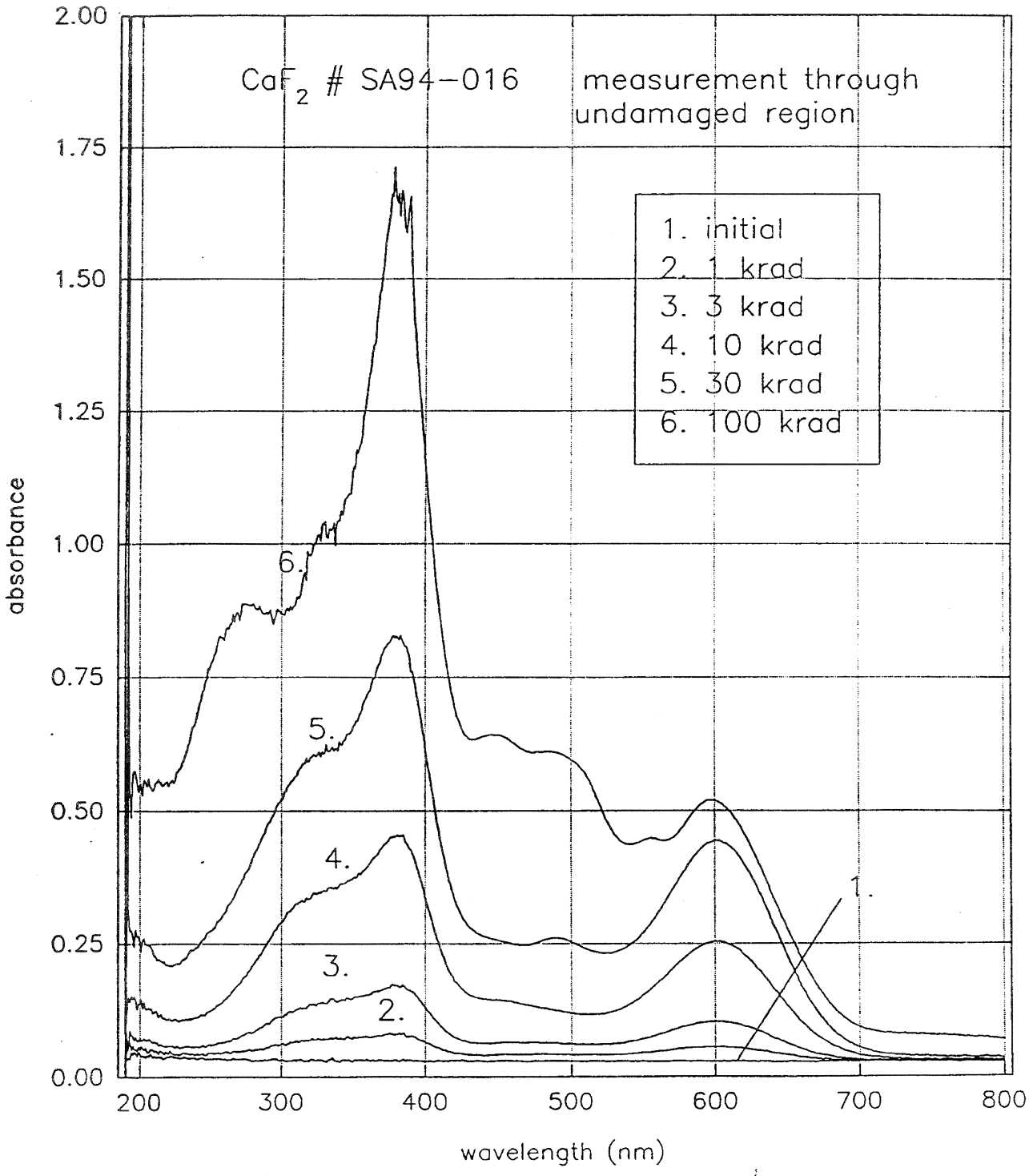

CaF2 # SA94-016
measurement through undamaged region
1. initial
2. 1 krad
3. 3 krad
4. 10 krad
5. 30 krad
6. 100 krad
absorbance
wavelength (nm)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
200
300
400
500
600
700
800
6.
5.
4.
3.
2.
1.

Figure 2

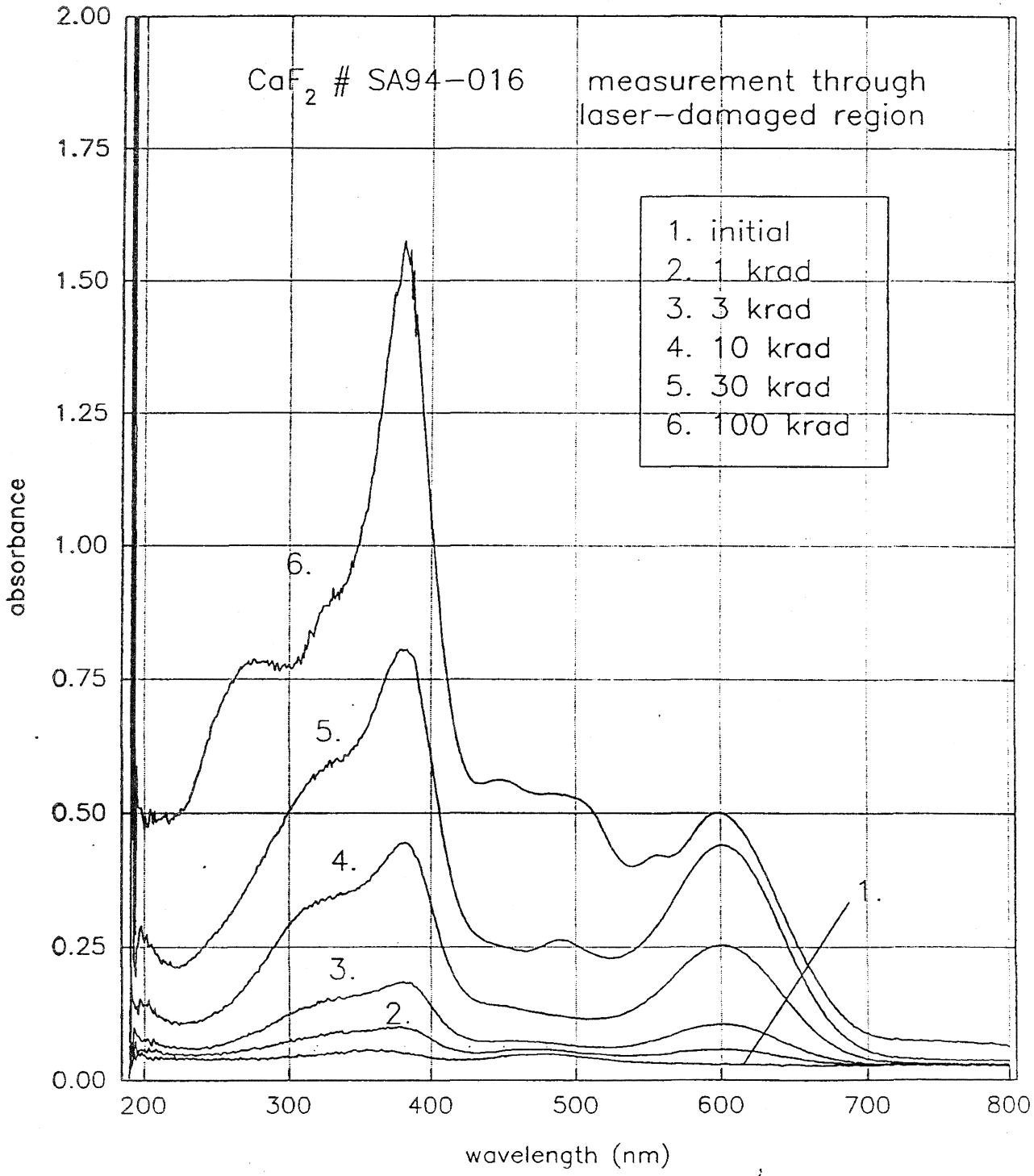

CaF2 # SA94-016
measurement through
laser-damaged region
1. initial
2. 1 krad
3. 3 krad
4. 10 krad
5. 30 krad
6. 100 krad
absorbance
wavelength (nm)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
200
300
400
500
600
700
800
6.
5.
4.
3.
2.
1.

Figure 3

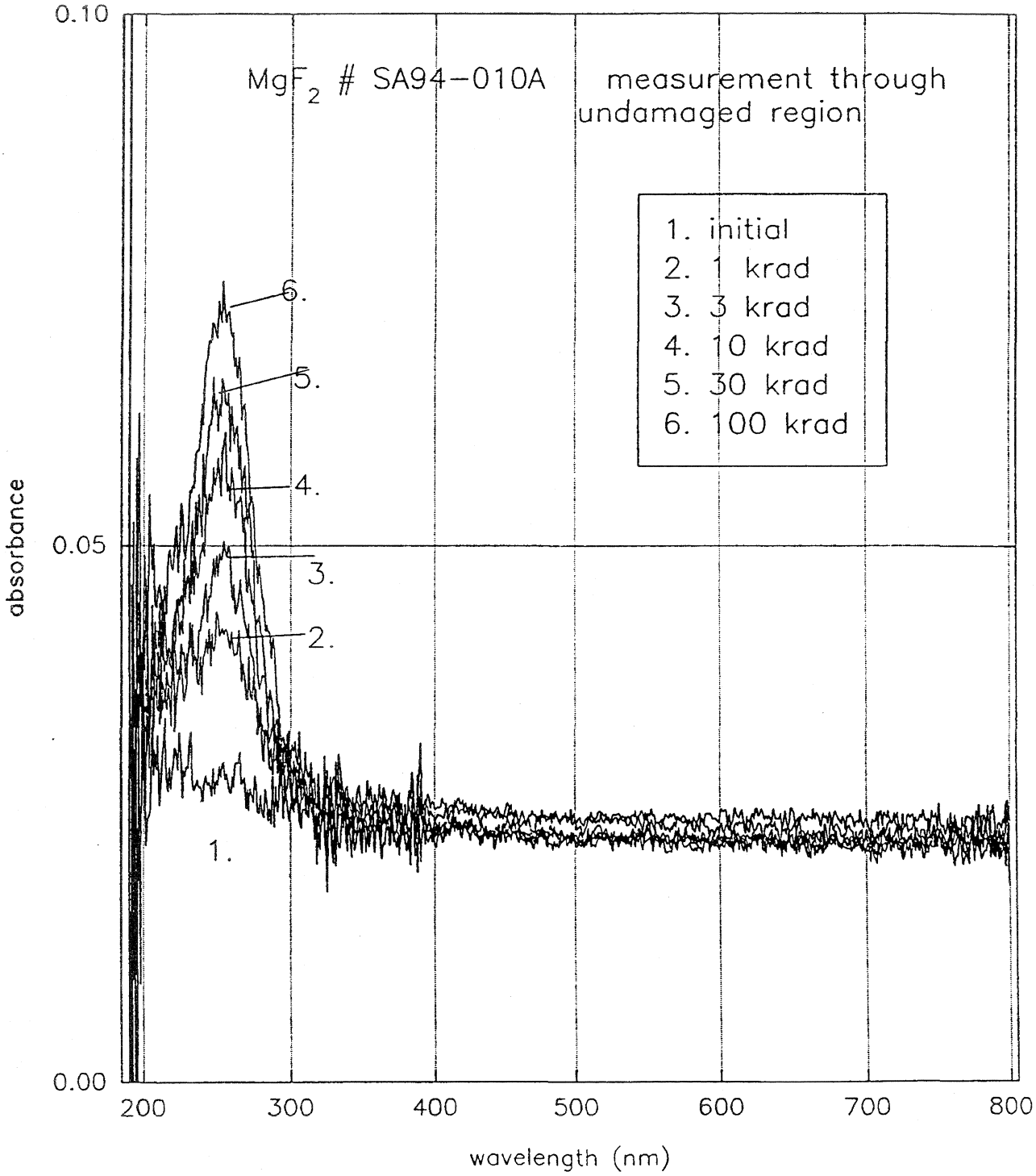

0.10
0.05
0.00
absorbance
MgF2 # SA94-010A
measurement through
undamaged region
1. initial
2. 1 krad
3. 3 krad
4. 10 krad
5. 30 krad
6. 100 krad
6.
5.
4.
3.
2.
1.
200
300
400
500
600
700
800
wavelength (nm)

Figure 4

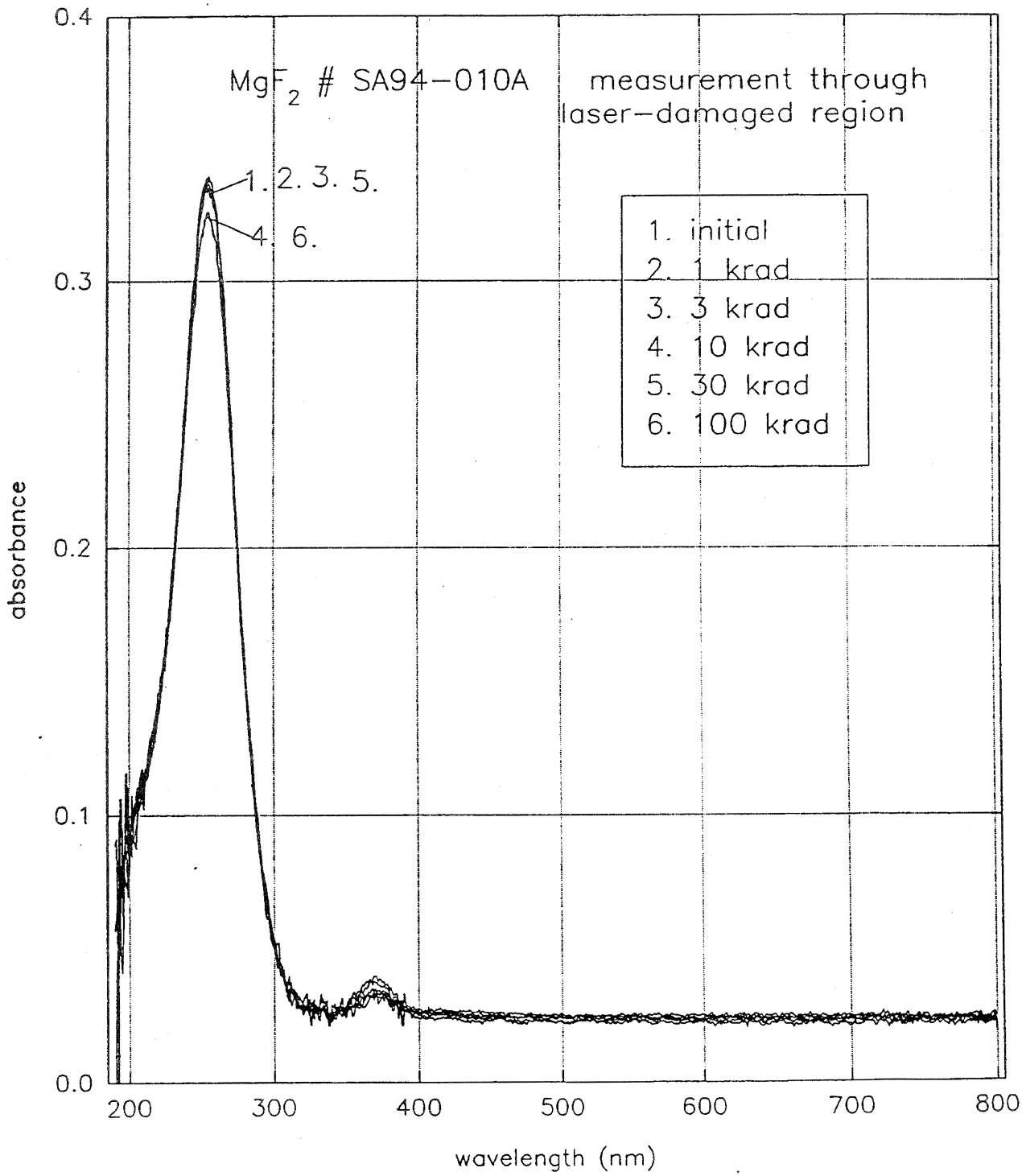

MgF2 # SA94-010A
measurement through
laser-damaged region
1. 2. 3. 5.
4. 6.
1. initial
2. 1 krad
3. 3 krad
4. 10 krad
5. 30 krad
6. 100 krad
absorbance
0.0
0.1
0.2
0.3
0.4
200
300
400
500
600
700
800
wavelength (nm)

Figure 5

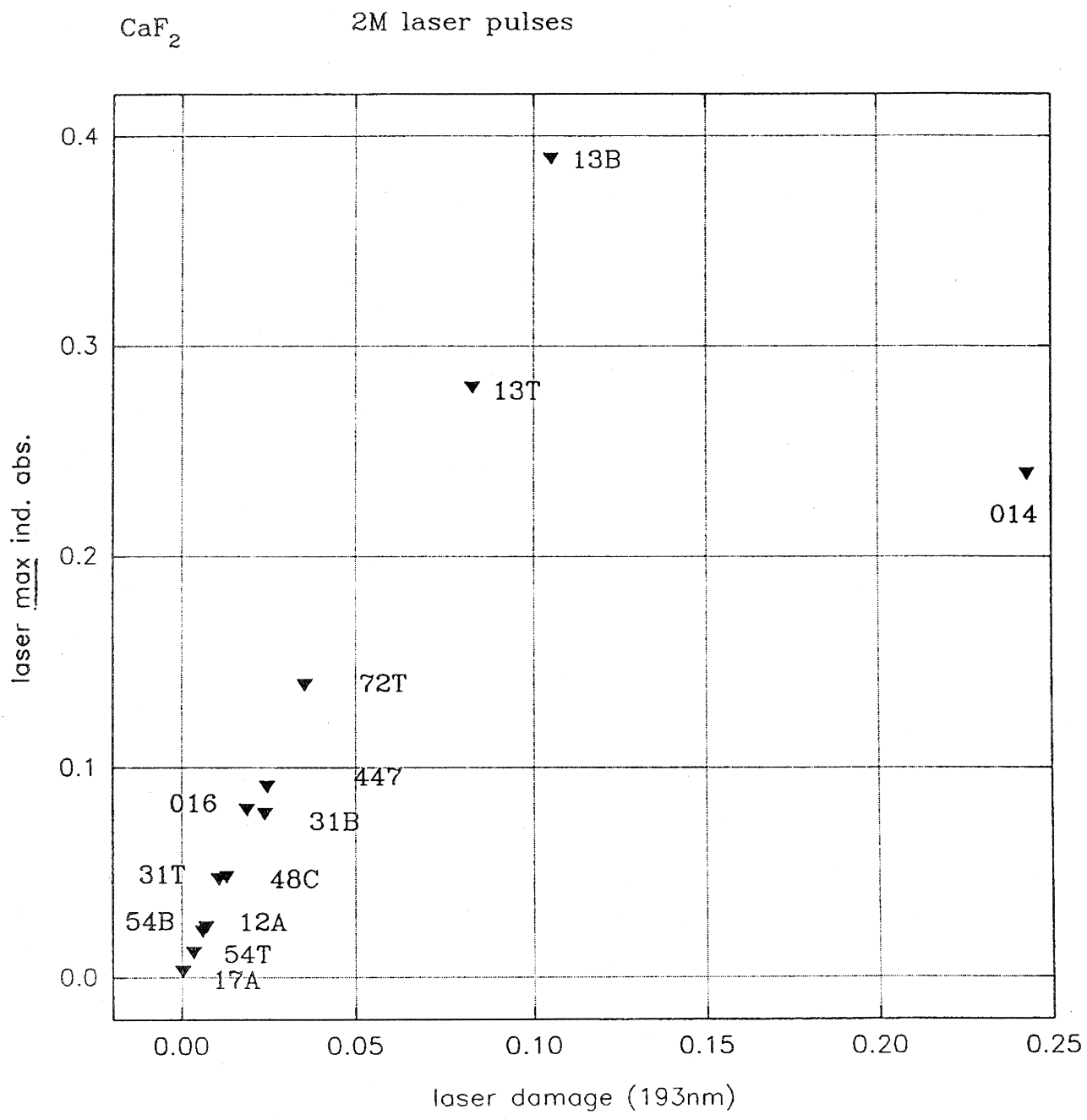

CaF2
2M laser pulses
0.4
0.3
0.2
0.1
0.0
laser max ind. abs.
13B
13T
014
72T
447
016
31B
31T
48C
54B
12A
54T
17A
0.00
0.05
0.10
0.15
0.20
0.25
laser damage (193nm)

Figure 6

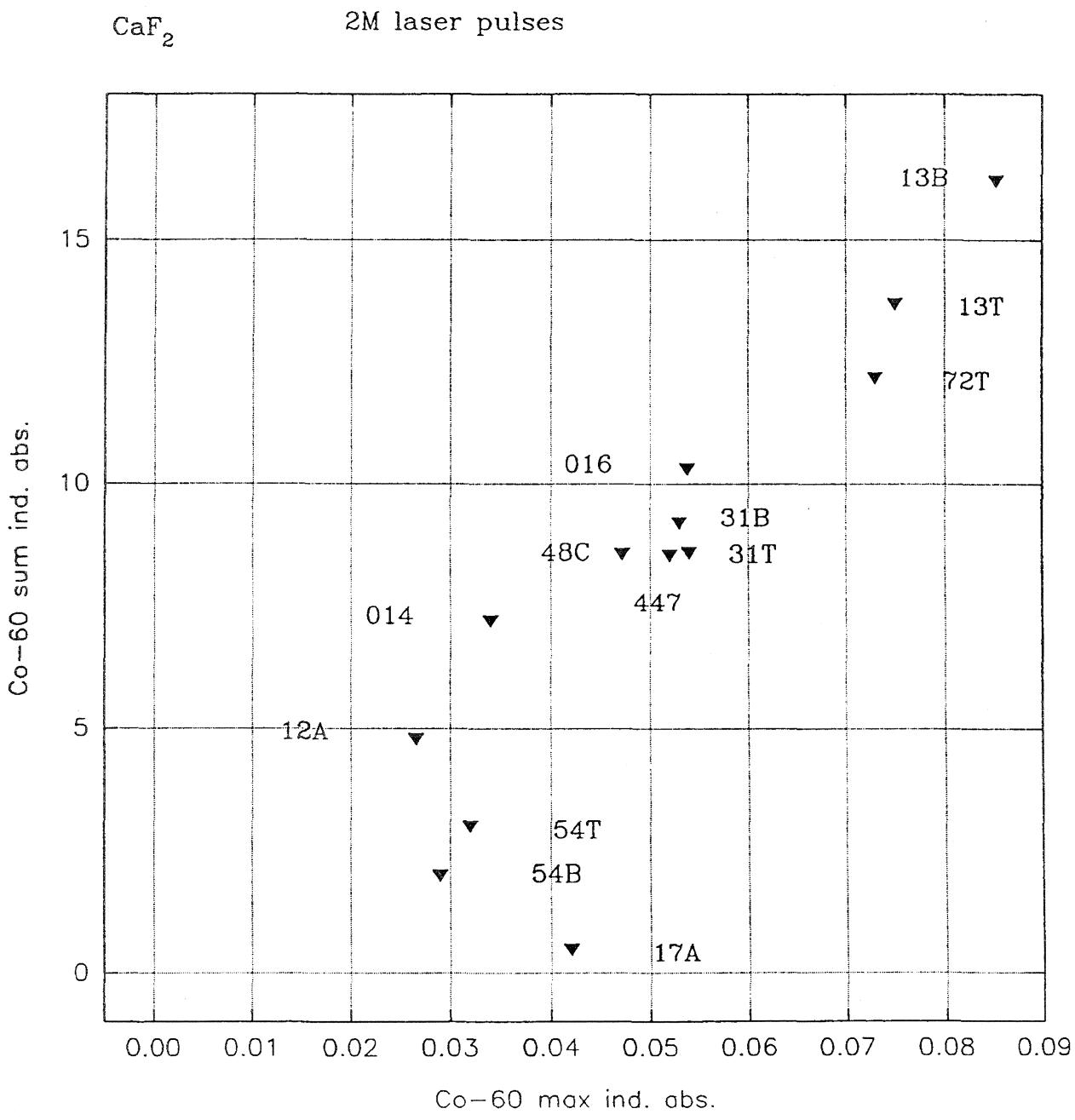

CaF2
2M laser pulses
13B
13T
72T
016
31B
48C
31T
447
014
12A
54T
54B
17A
15
10
5
0
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Co-60 sum ind. abs.
Co-60 max ind. abs.

Figure 7

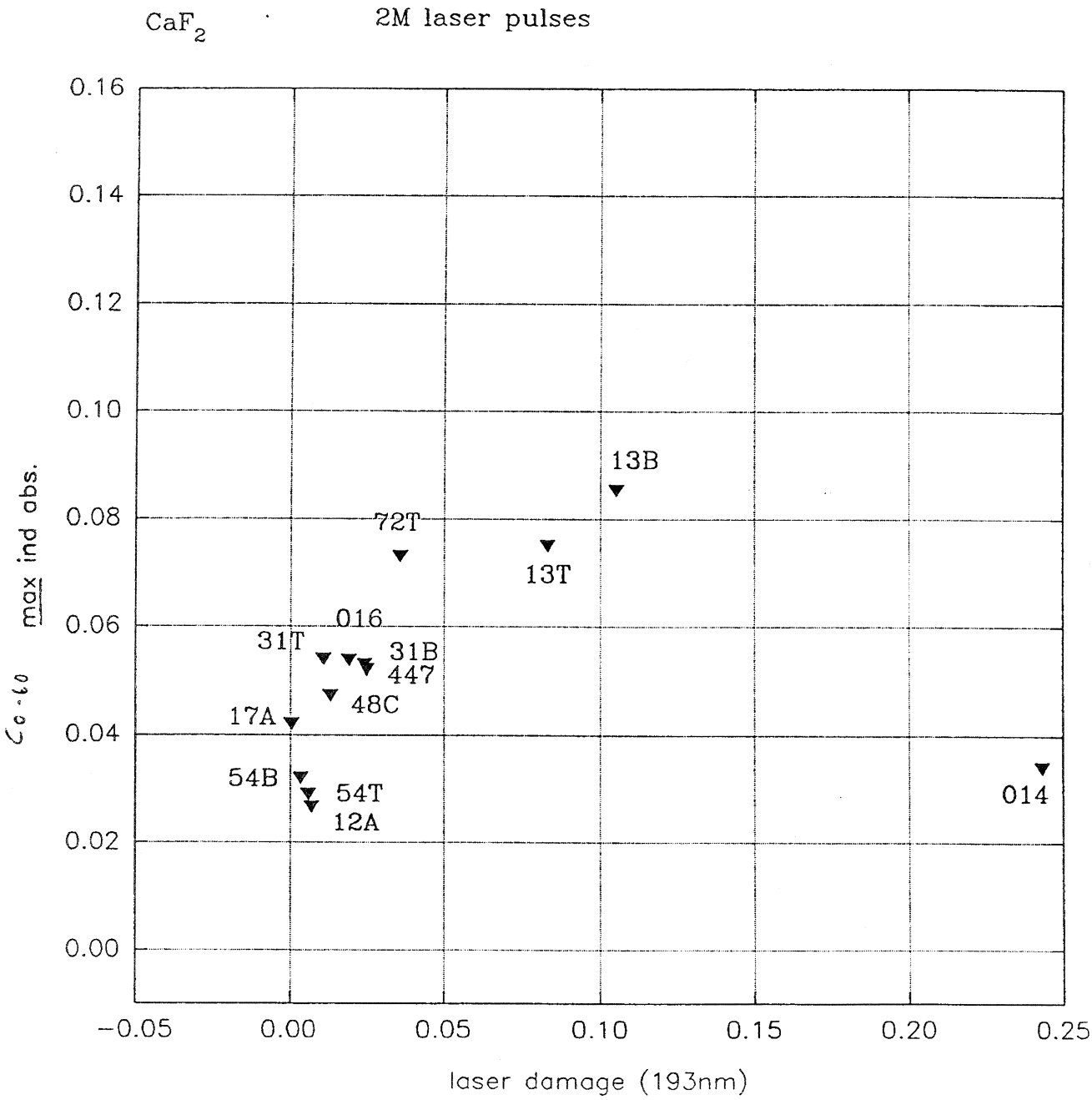

CaF2
2M laser pulses
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
max ind abs.
13B
72T
13T
016
31T
31B
447
48C
17A
54B
54T
12A
014
−0.05
0.00
0.05
0.10
0.15
0.20
0.25
laser damage (193nm)

Figure 8

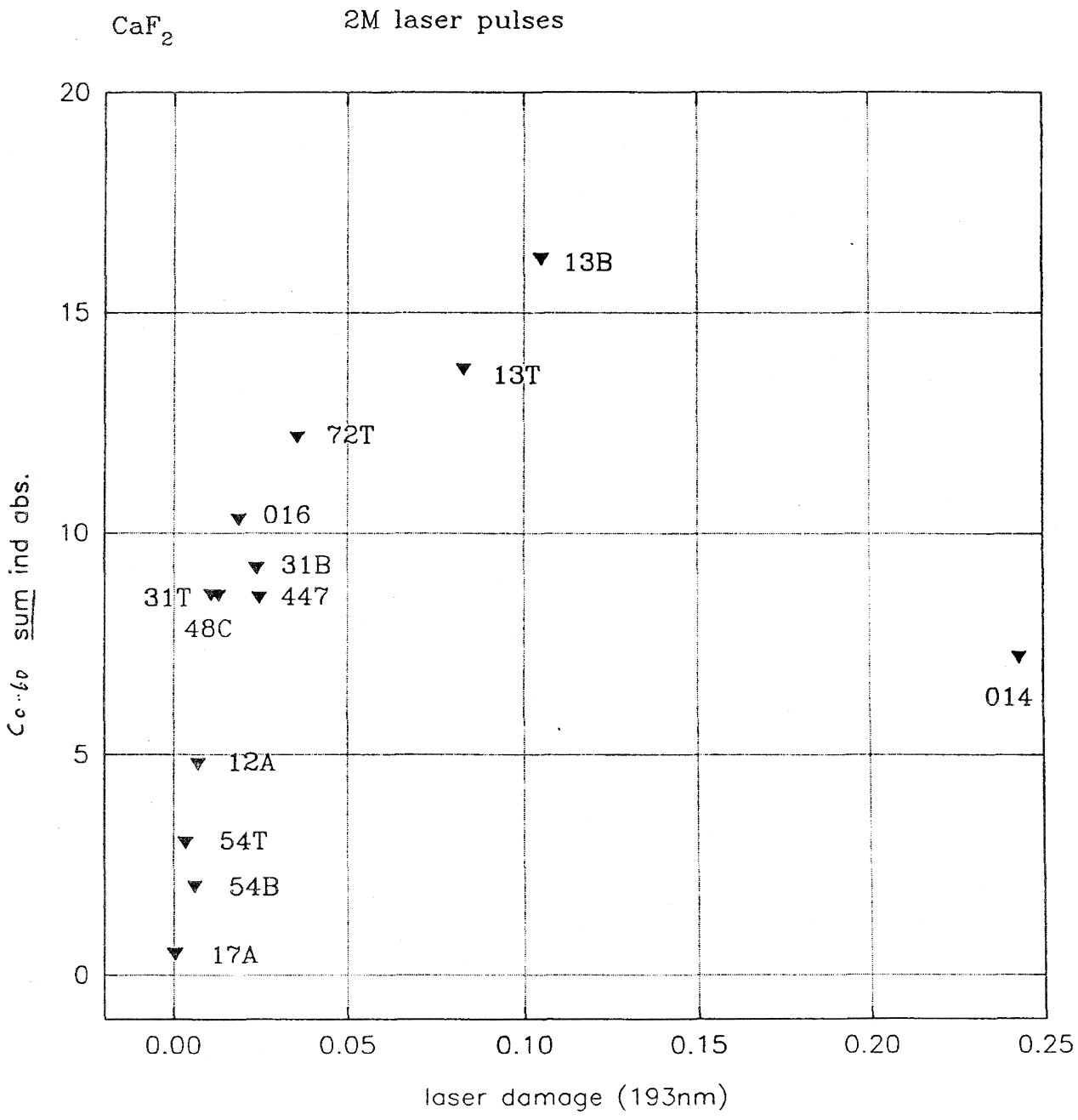

CaF2
2M laser pulses
20
15
10
5
0
13B
13T
72T
016
31B
31T
447
48C
014
12A
54T
54B
17A
0.00
0.05
0.10
0.15
0.20
0.25
laser damage (193nm)
sum ind abs.

Figure 9

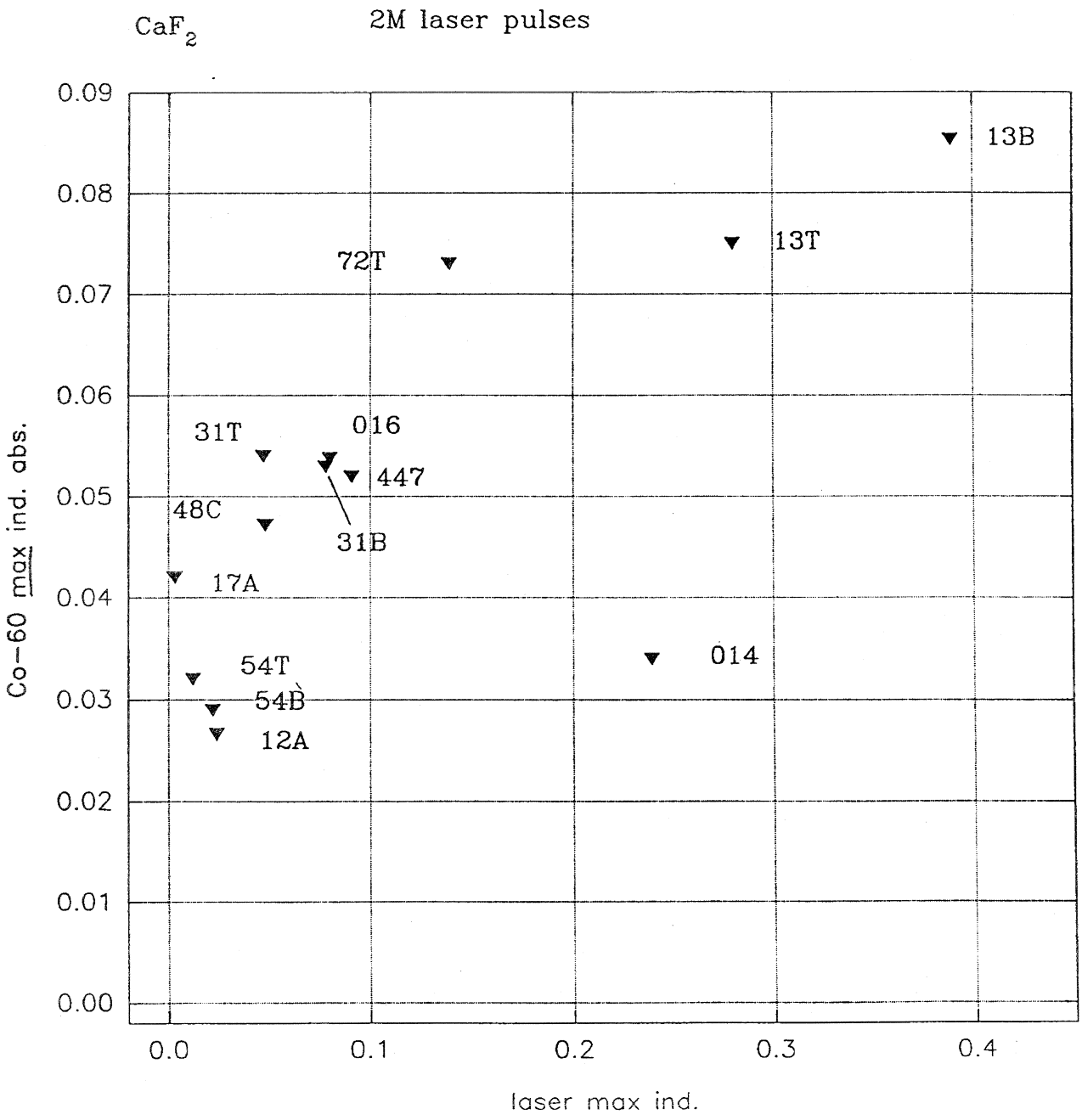

CaF2
2M laser pulses
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Co-60 max ind. abs.
0.0
0.1
0.2
0.3
0.4
laser max ind.
13B
13T
72T
31T
016
447
48C
31B
17A
014
54T
54B
12A

Figure 10

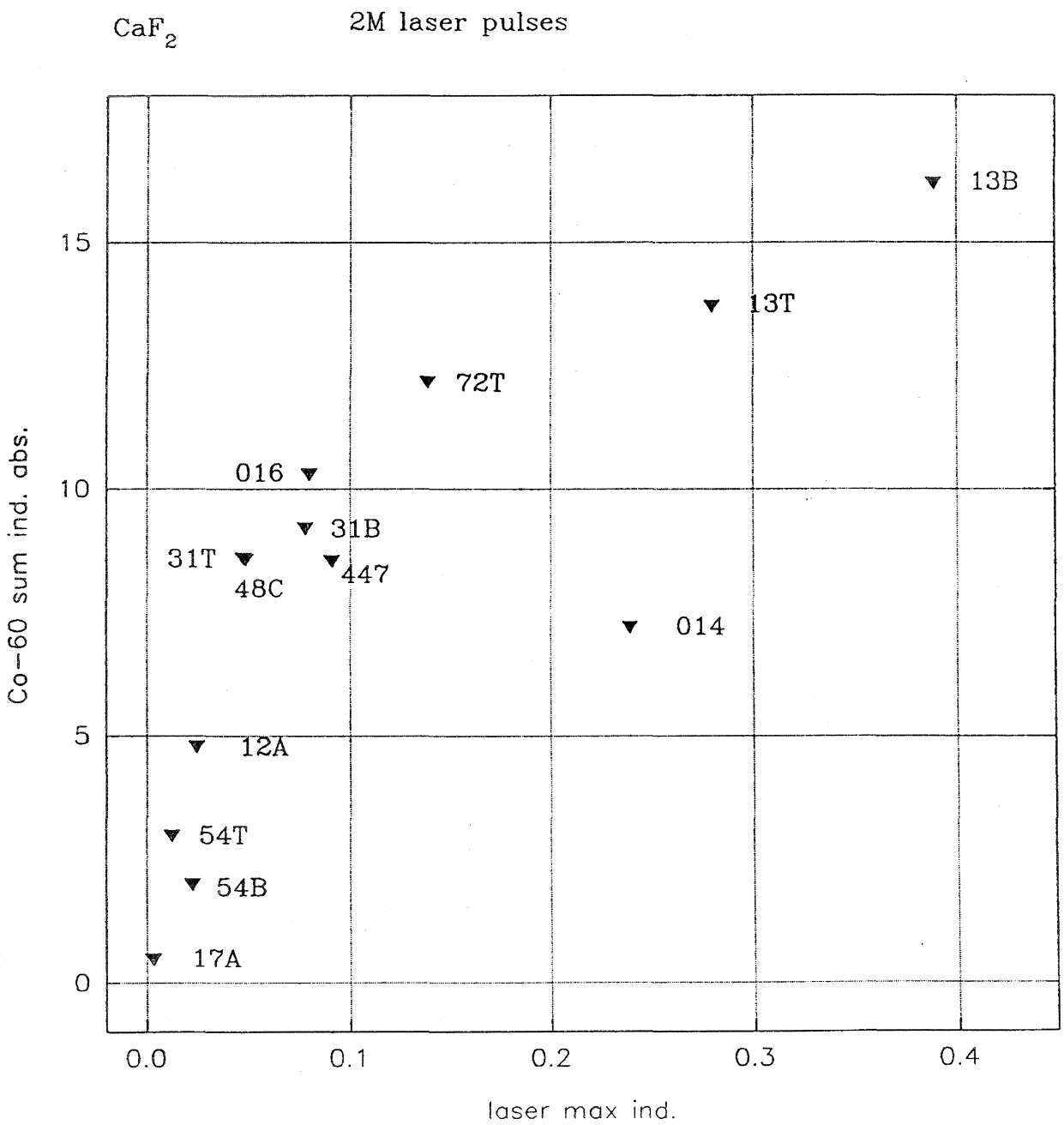

CaF2
2M laser pulses
13B
13T
72T
016
31B
31T
48C
447
014
12A
54T
54B
17A
15
10
5
0
0.0
0.1
0.2
0.3
0.4
Co-60 sum ind. abs.
laser max ind.

Figure 11

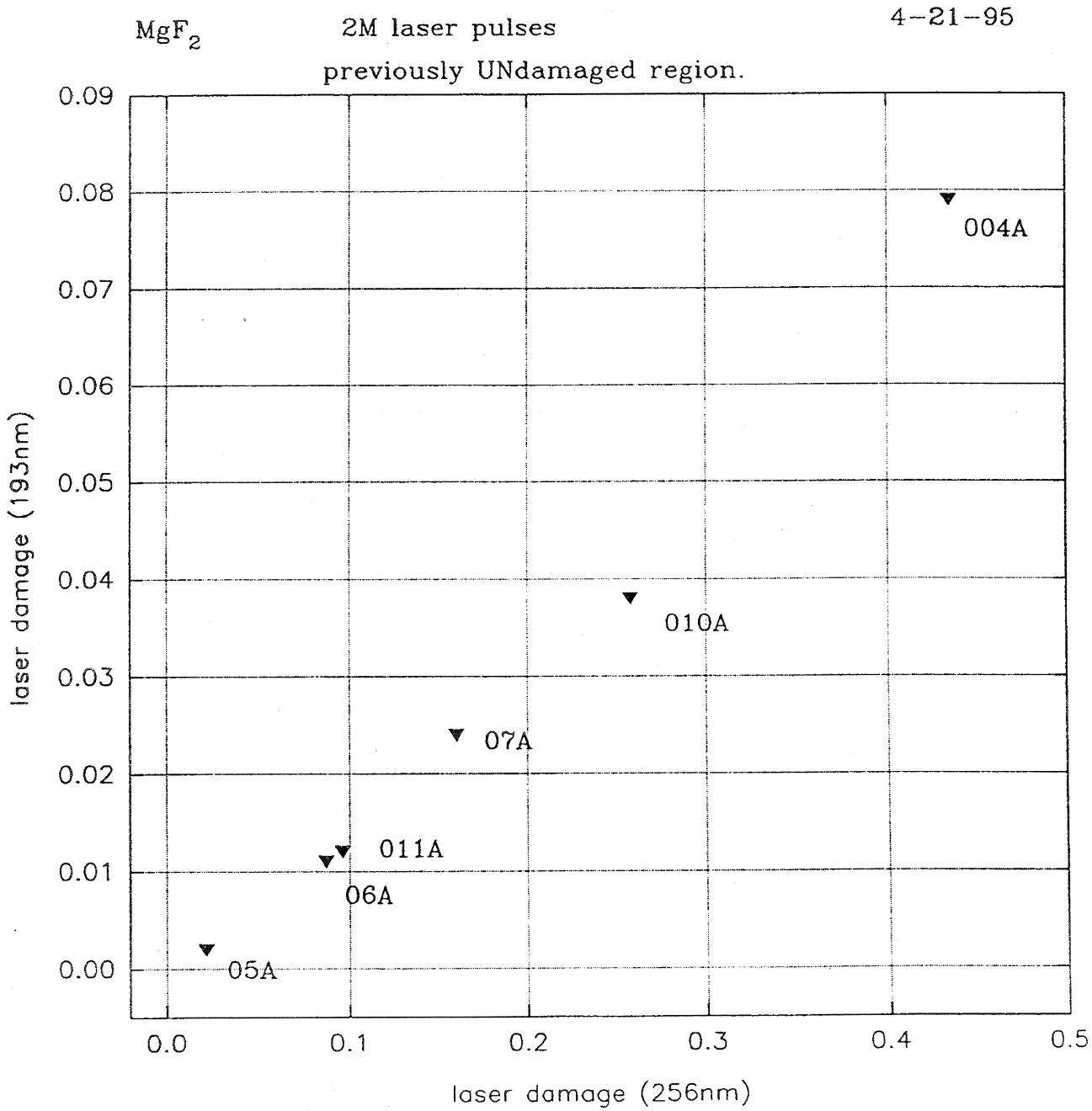

MgF2
2M laser pulses
previously UNdamaged region.
4-21-95
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
laser damage (193nm)
004A
010A
07A
011A
06A
05A
0.0
0.1
0.2
0.3
0.4
0.5
laser damage (256nm)

Figure 12

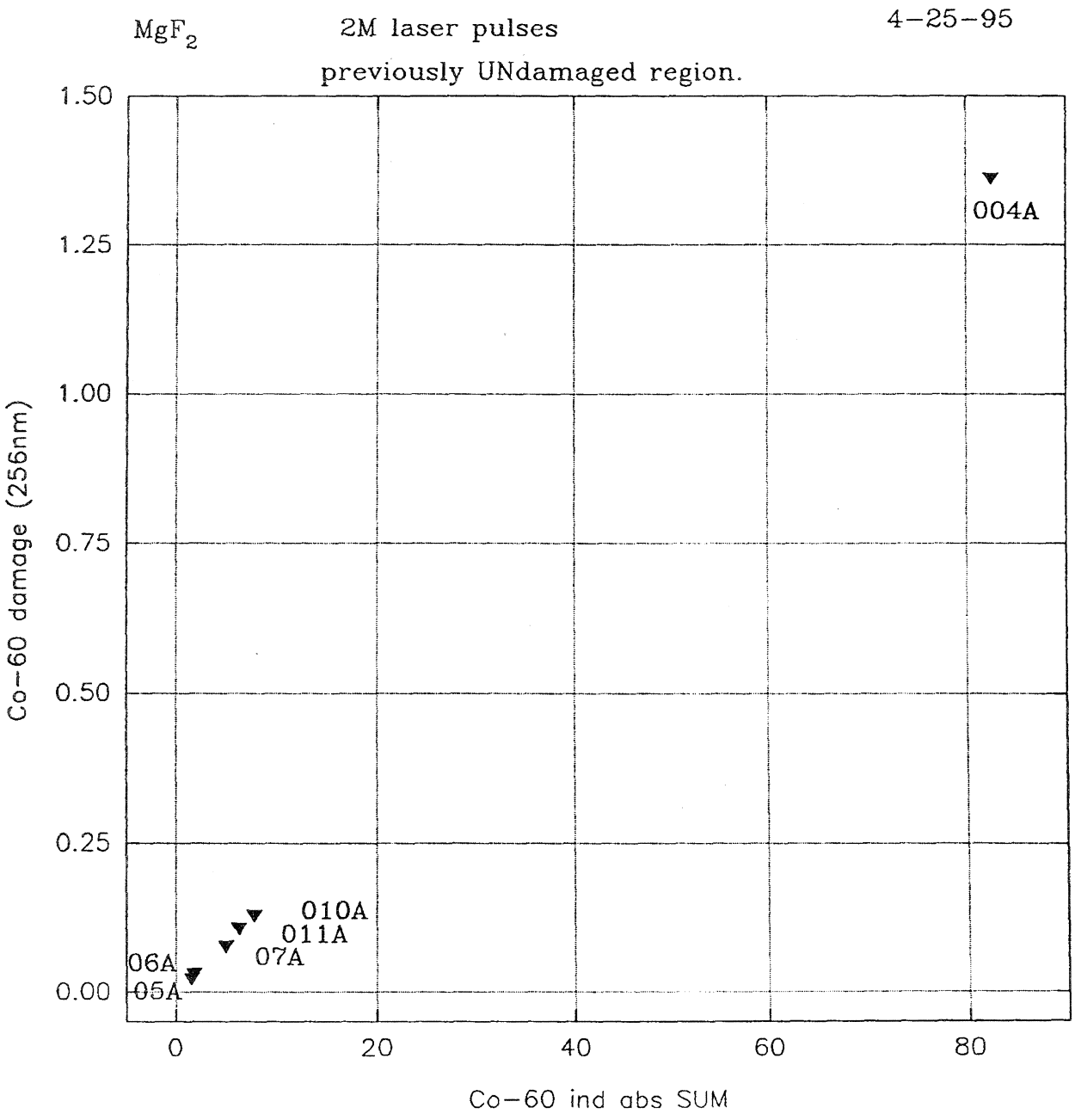

MgF2
2M laser pulses
previously UNdamaged region.
4-25-95
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Co-60 damage (256nm)
004A
010A
011A
07A
06A
05A
0
20
40
60
80
Co-60 ind abs SUM

Figure 13

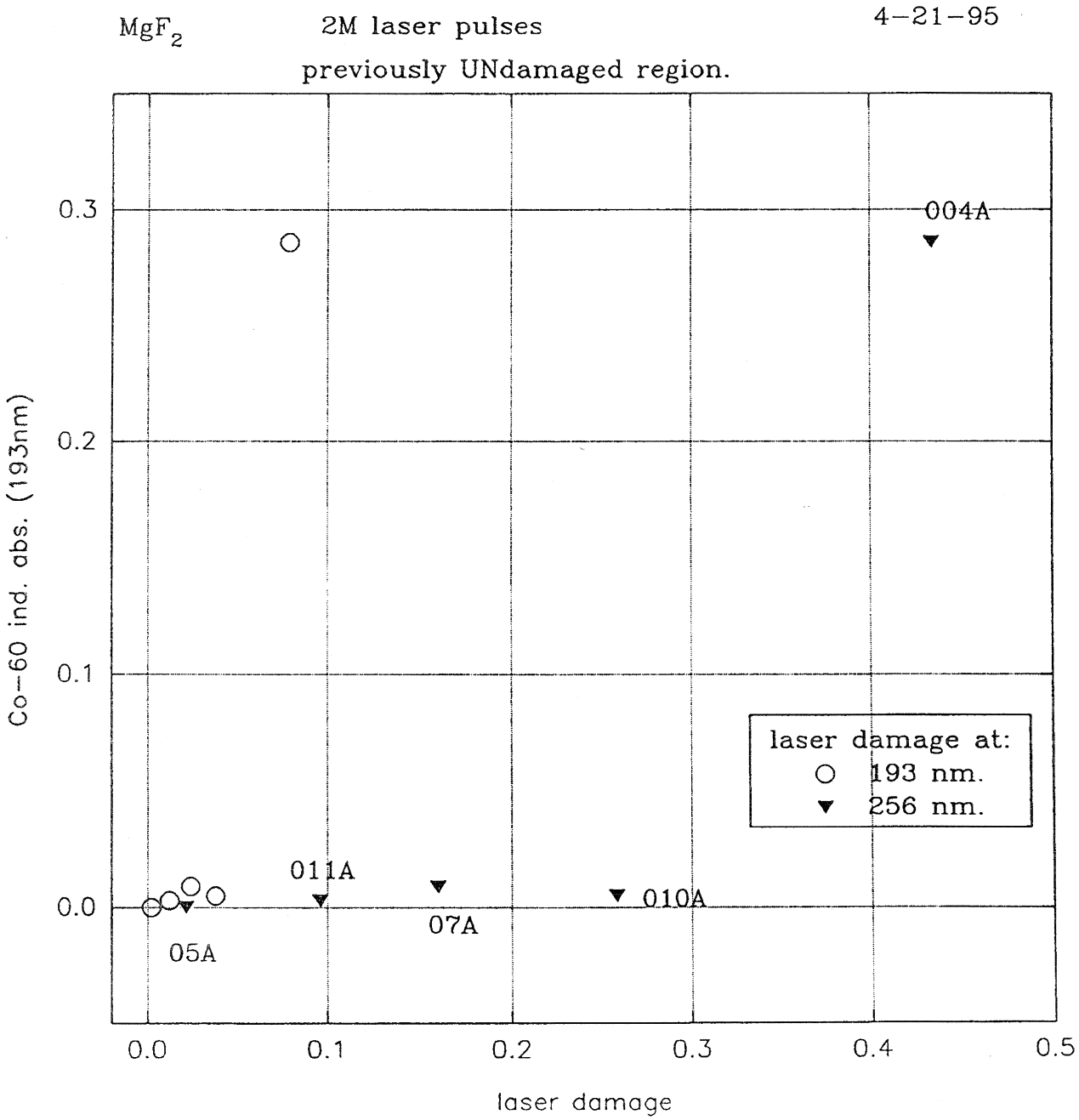

MgF2
2M laser pulses
previously UNdamaged region.
4-21-95
Co-60 ind. abs. (193nm)
0.3
0.2
0.1
0.0
004A
011A
07A
010A
05A
laser damage at:
193 nm.
256 nm.
0.0
0.1
0.2
0.3
0.4
0.5
laser damage

Figure 14

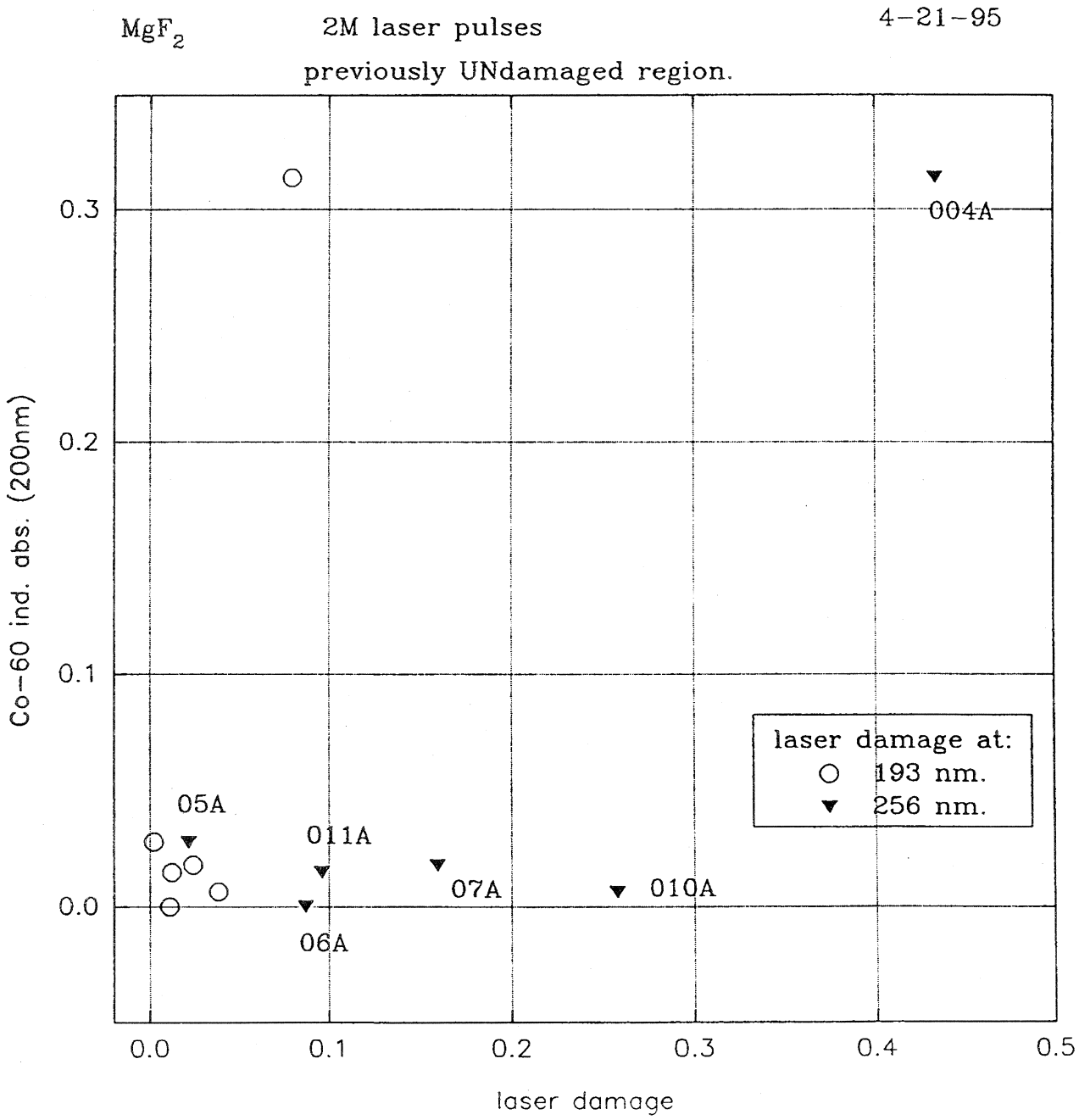

MgF2
2M laser pulses
previously UNdamaged region.
4-21-95
0.3
0.2
0.1
0.0
Co-60 ind. abs. (200nm)
004A
05A
011A
07A
010A
06A
laser damage at:
193 nm.
256 nm.
0.0
0.1
0.2
0.3
0.4
0.5
laser damage

Figure 15

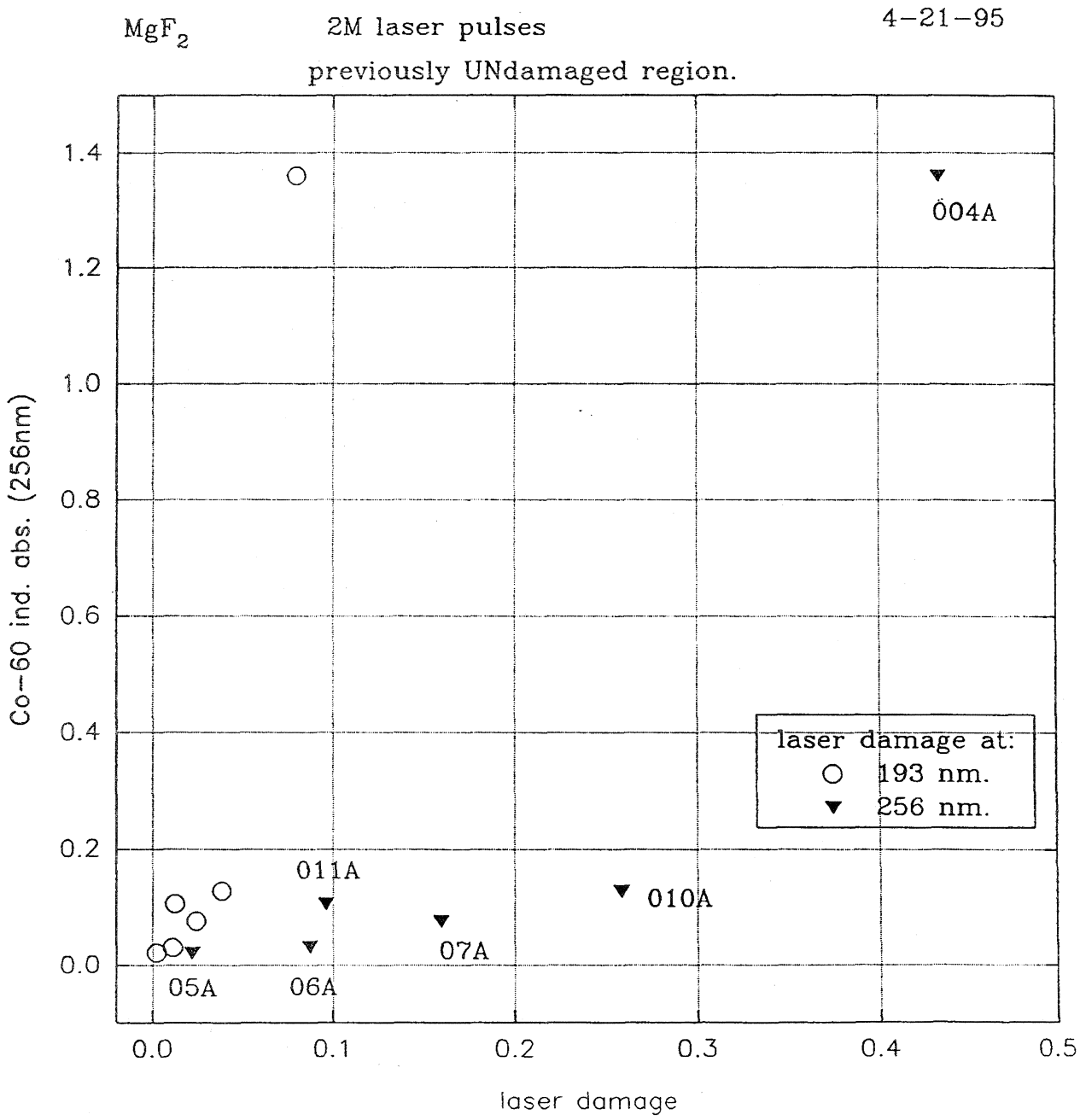

MgF2
2M laser pulses
previously UNdamaged region.
4-21-95
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Co-60 ind. abs. (256nm)
004A
011A
010A
07A
05A
06A
laser damage at:
193 nm.
256 nm.
0.0
0.1
0.2
0.3
0.4
0.5
laser damage

Figure 16

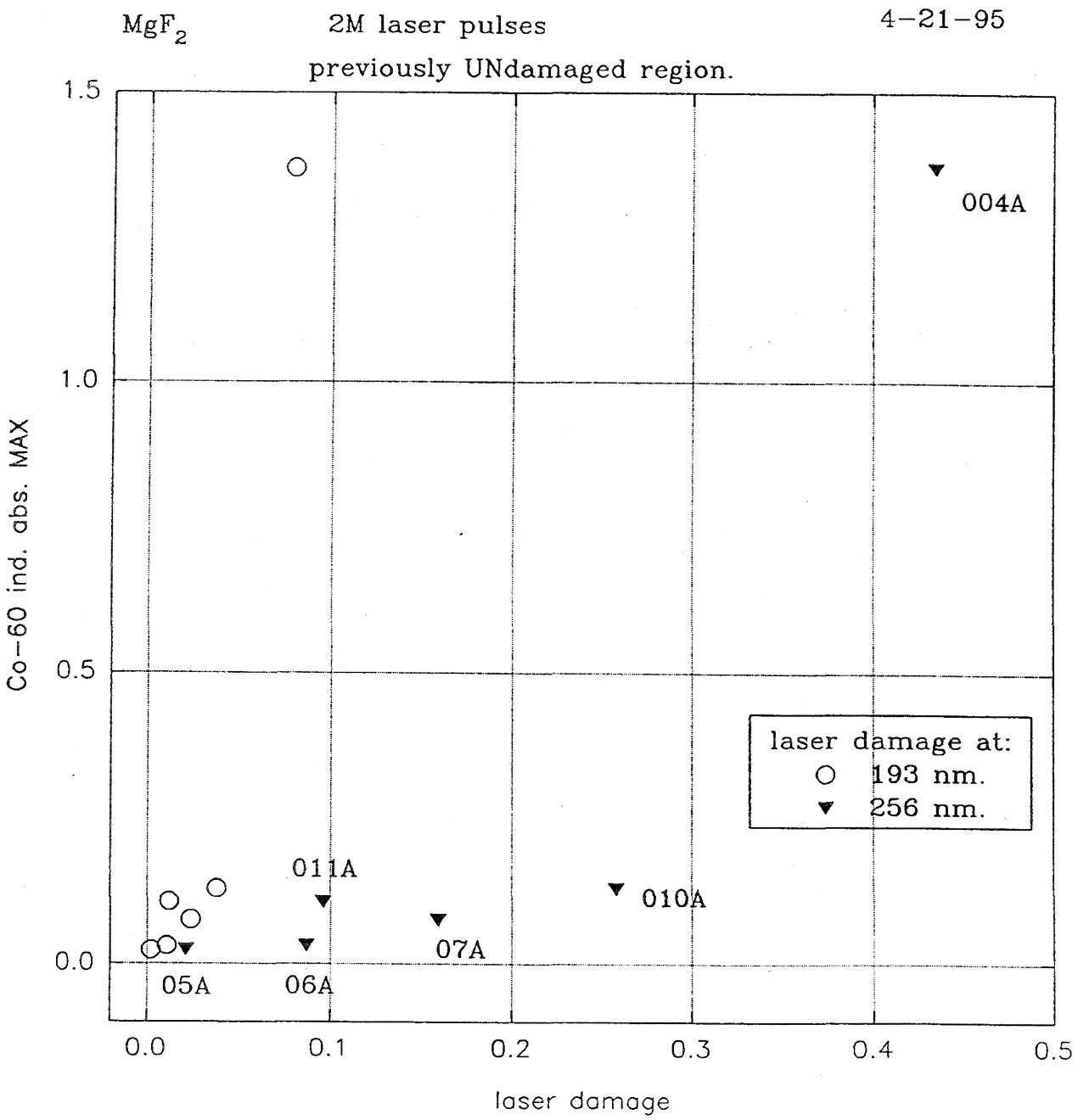

MgF2
2M laser pulses
previously UNdamaged region.
4-21-95
1.5
1.0
0.5
0.0
Co-60 ind. abs. MAX
004A
011A
010A
07A
05A
06A
laser damage at:
193 nm.
256 nm.
0.0
0.1
0.2
0.3
0.4
0.5
laser damage

Figure 17

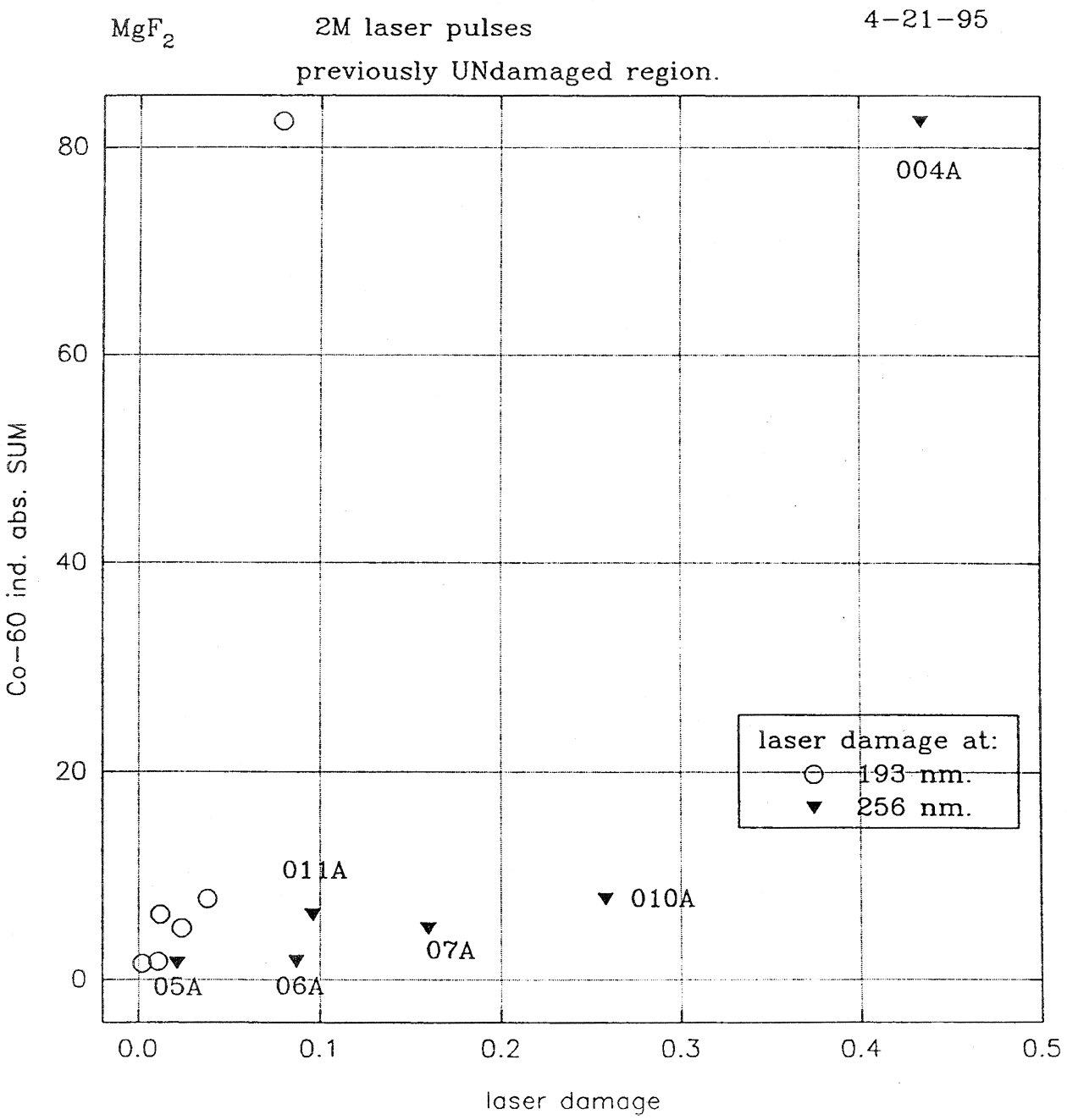

MgF2
2M laser pulses
previously UNdamaged region.
4-21-95
80
60
40
20
0
Co-60 ind. abs. SUM
004A
011A
010A
07A
05A
06A
laser damage at:
193 nm.
256 nm.
0.0
0.1
0.2
0.3
0.4
0.5
laser damage

Figure 18

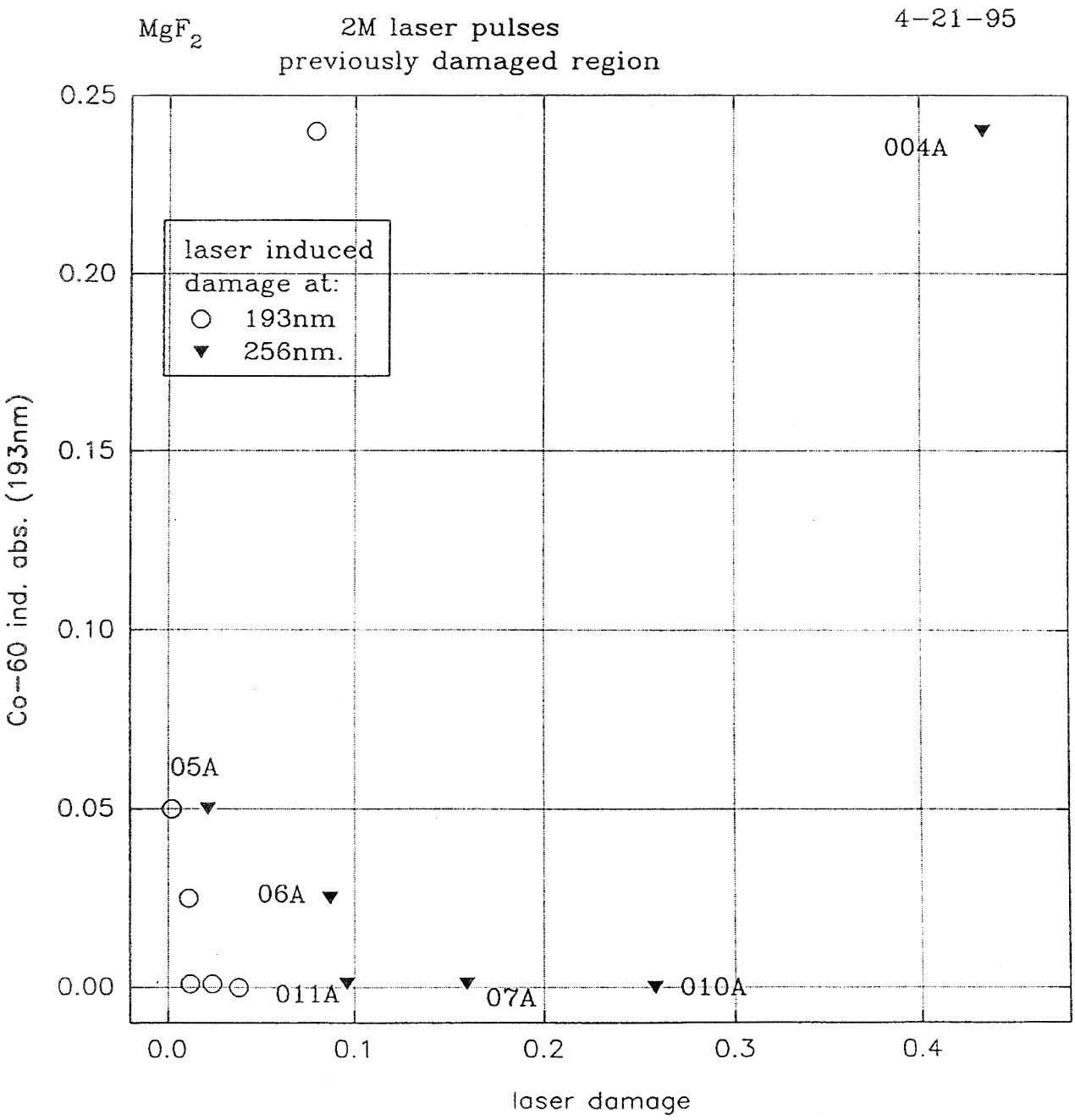

MgF2
2M laser pulses
previously damaged region
4-21-95
laser induced
damage at:
193nm
256nm.
004A
05A
06A
011A
07A
010A
0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.1
0.2
0.3
0.4
Co-60 ind. abs. (193nm)
laser damage

Figure 19

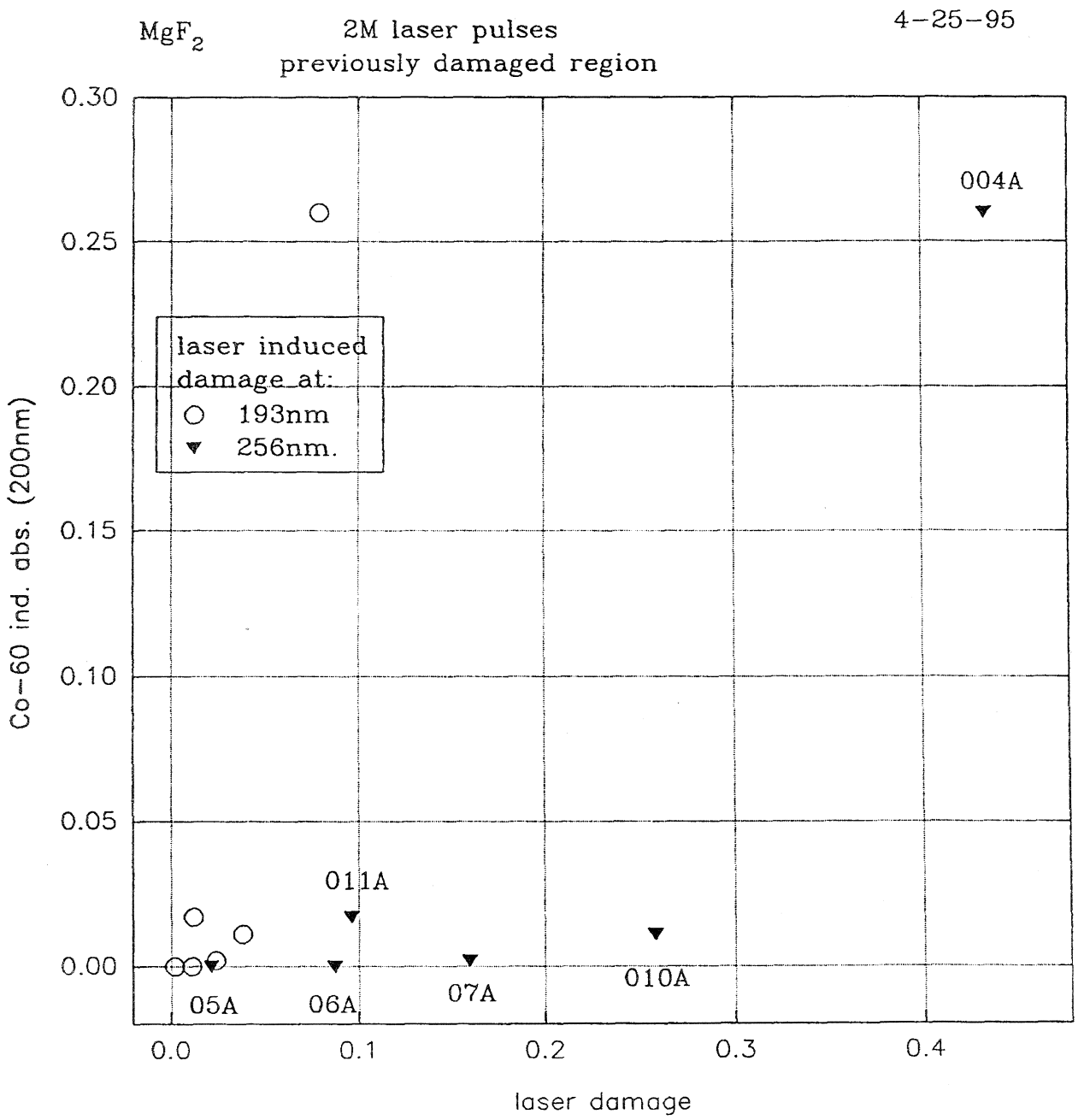

MgF2
2M laser pulses
previously damaged region
4-25-95
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Co-60 ind. abs. (200nm)
laser induced
damage at:
193nm
256nm.
004A
011A
05A
06A
07A
010A
0.0
0.1
0.2
0.3
0.4
laser damage

Figure 20

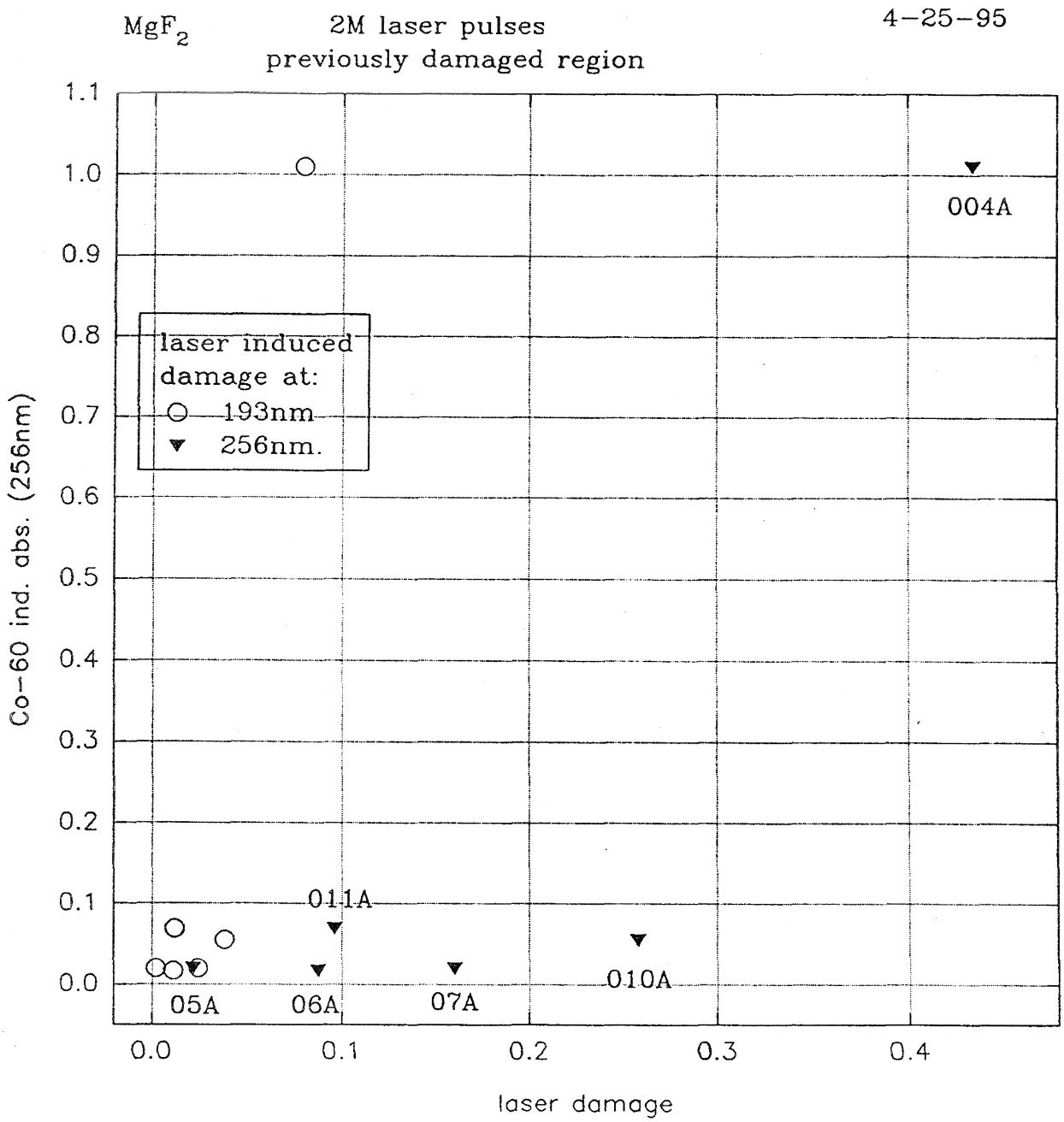

MgF2
2M laser pulses
previously damaged region
4-25-95
laser induced
damage at:
193nm
256nm.
004A
011A
010A
05A
06A
07A
Co-60 ind. abs. (256nm)
laser damage
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4

Figure 21

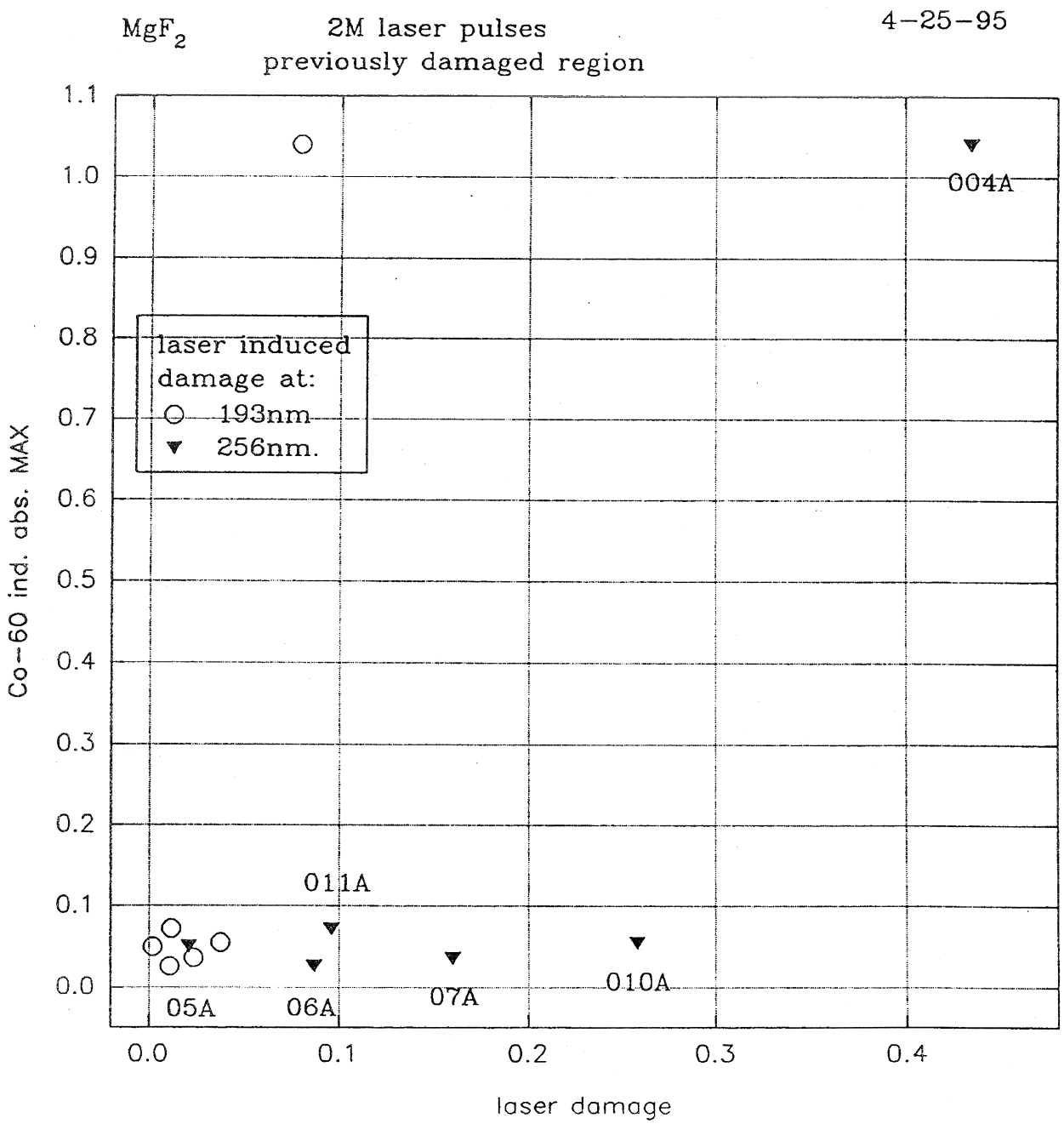
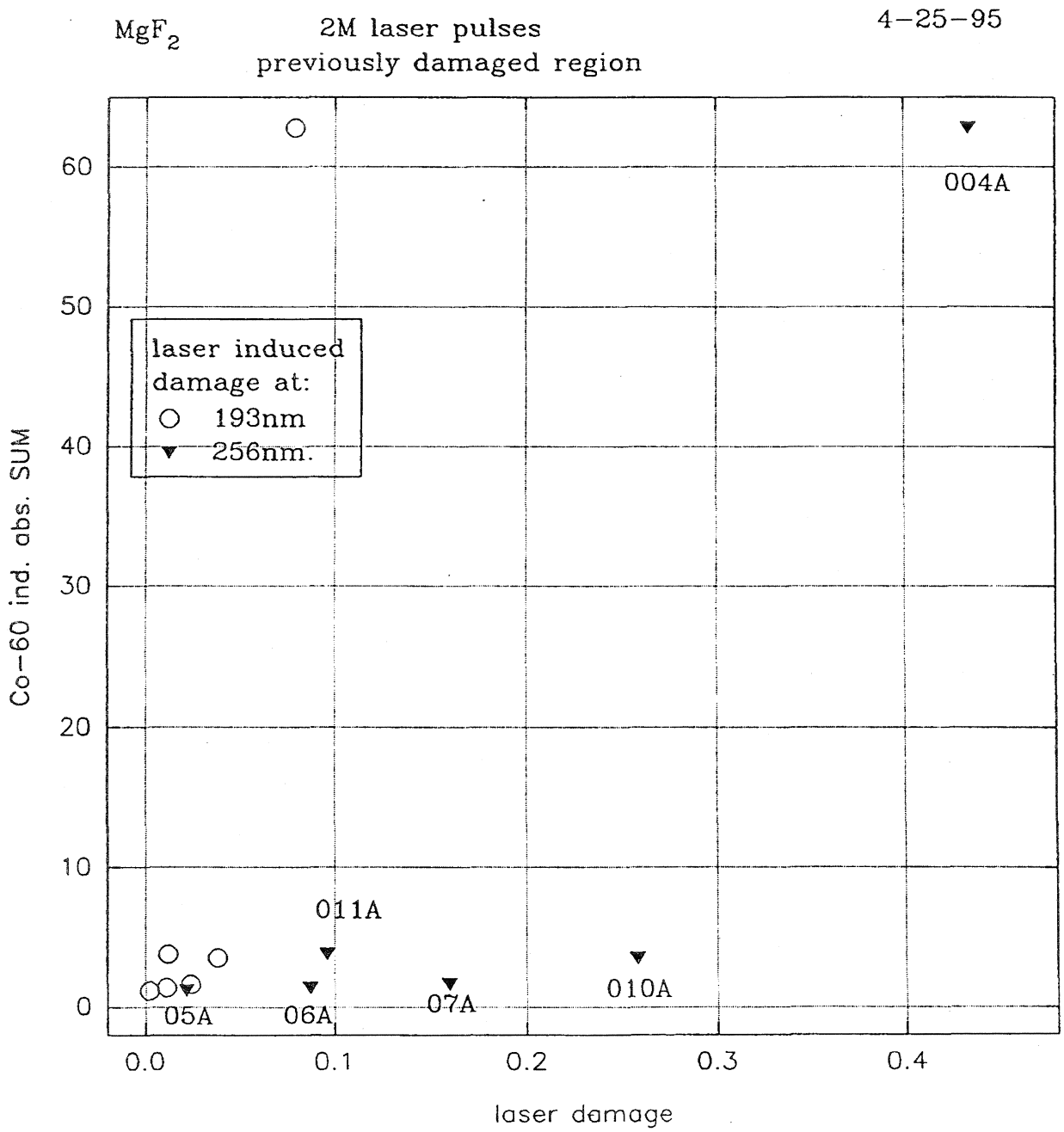

MgF2
2M laser pulses
previously damaged region
4-25-95
laser induced
damage at:
193nm
256nm.
004A
011A
010A
05A
06A
07A
Co-60 ind. abs. MAX
laser damage
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4

Figure 22

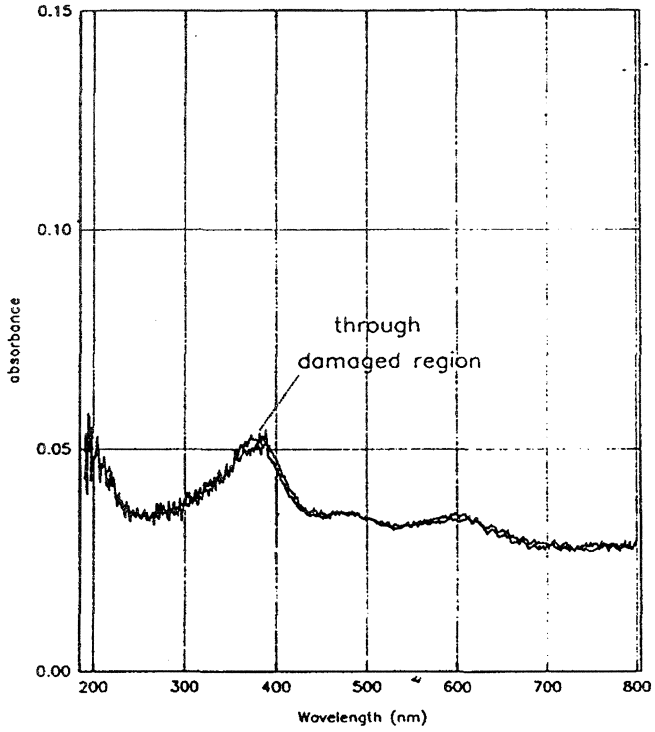

MgF2
2M laser pulses
previously damaged region
4-25-95
laser induced
damage at:
193nm
256nm.
004A
011A
05A
06A
07A
010A
Co-60 ind. abs. SUM
laser damage
0
10
20
30
40
50
60
0.0
0.1
0.2
0.3
0.4

APPENDIX A

Absorbance Spectra for 193 nm Excimer Laser Exposures at MIT and ^{60}Co Gamma Ray Exposures at BNL

CaF_2 1446

Optovac CaF_2 #SA92 058 1446A 12/21/94



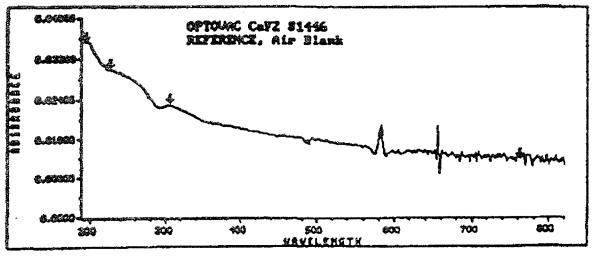
---> WAVELENGTH SCAN REPORT <---

Date : 11-21-1992
Time : 09:04:52
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF1446RF.WAV

Sample Name : CF1446RF
Solvent Name : OP CaF2 1446 RF
Concentration : 0.00E+00
Units : NONE Sub RSF

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1 :	Wavelength = 192	Result =	0.035263
2 :	Wavelength = 194	Result =	0.038324
3 :	Wavelength = 226	Result =	0.021987
4 :	Wavelength = 306	Result =	0.022964
5 :	Wavelength = 762	Result =	0.011708

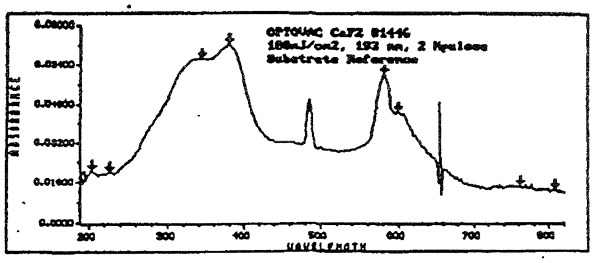
---> WAVELENGTH SCAN REPORT <---

Date : 11-21-1992
Time : 13:21:46
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF1446ZM.WAV

Sample Name : CF1446ZM
Solvent Name : OP CaF2:1446 ZM
Concentration : 100.0000
Units : mJ/cm2 Sub Rf

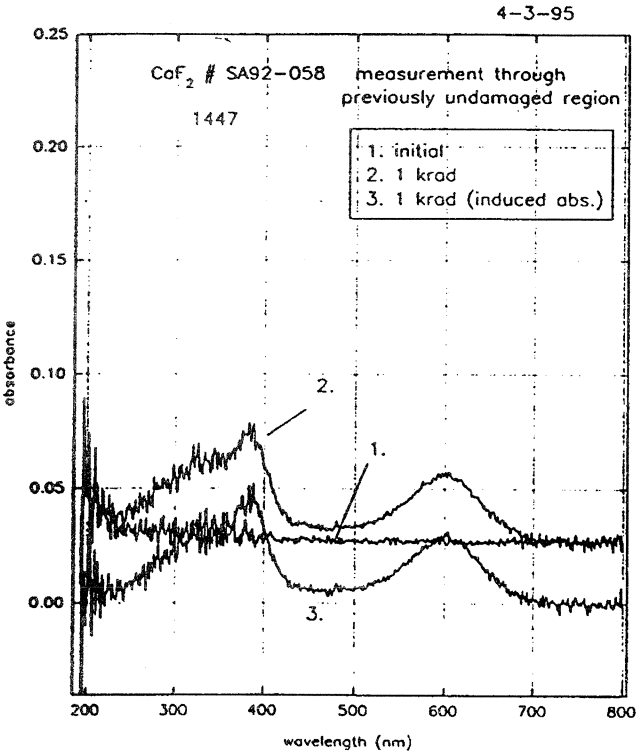
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF

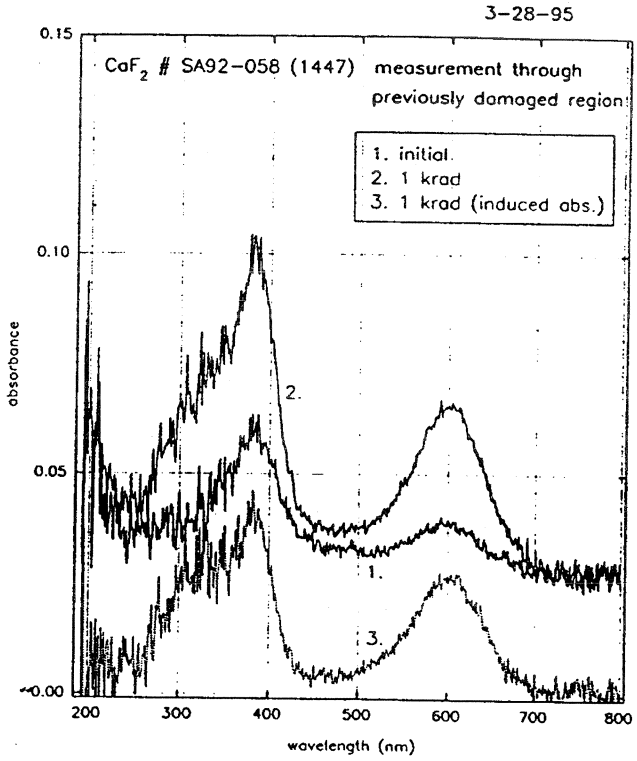


Annotated Wavelengths:

1 :	Wavelength = 192	Result =	0.016488
2 :	Wavelength = 194	Result =	0.016386
3 :	Wavelength = 204	Result =	0.020462
4 :	Wavelength = 226	Result =	0.019806
5 :	Wavelength = 344	Result =	0.066366
6 :	Wavelength = 388	Result =	0.071916
7 :	Wavelength = 582	Result =	0.059830
8 :	Wavelength = 680	Result =	0.044739
9 :	Wavelength = 762	Result =	0.014130
10 :	Wavelength = 808	Result =	0.012497

CaF_2 1447 (447)





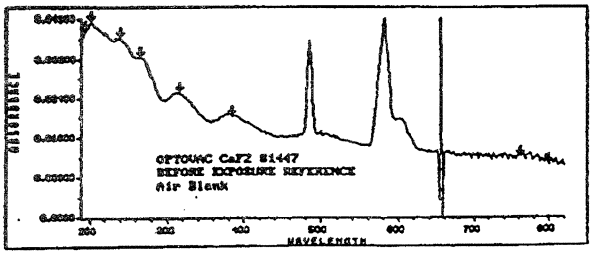
---> WAVELENGTH SCAN REPORT <---

Date : 11-21-1992
Time : 13:34:33
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF1447RF.WAV

Sample Name : CF1447RF
Solvent Name : OP CaF2 1447 RF
Concentration : 0.00E+00
Units : NONE Air Blank

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1	Wavelength = 192	Result =	0.037040
2	Wavelength = 194	Result =	0.037506
3	Wavelength = 202	Result =	0.039352
4	Wavelength = 240	Result =	0.036133
5	Wavelength = 266	Result =	0.032354
6	Wavelength = 316	Result =	0.025070
7	Wavelength = 384	Result =	0.020142
8	Wavelength = 752	Result =	0.011948
9	Wavelength = 766	Result =	0.010450

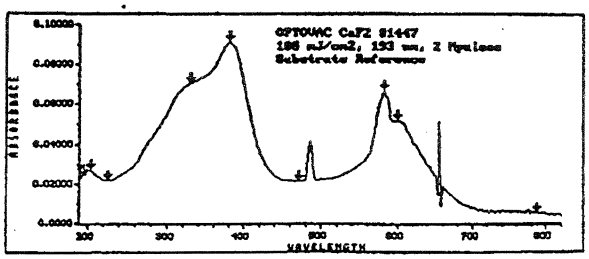
---> WAVELENGTH SCAN REPORT <---

Date : 11-22-1992
Time : 13:07:12
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF1447ZM.WAV

Sample Name : CF1447ZM
Solvent Name : OP CaF2 1447 ZM
Concentration : 100.0000
Units : mJ/cm2 Sub RF

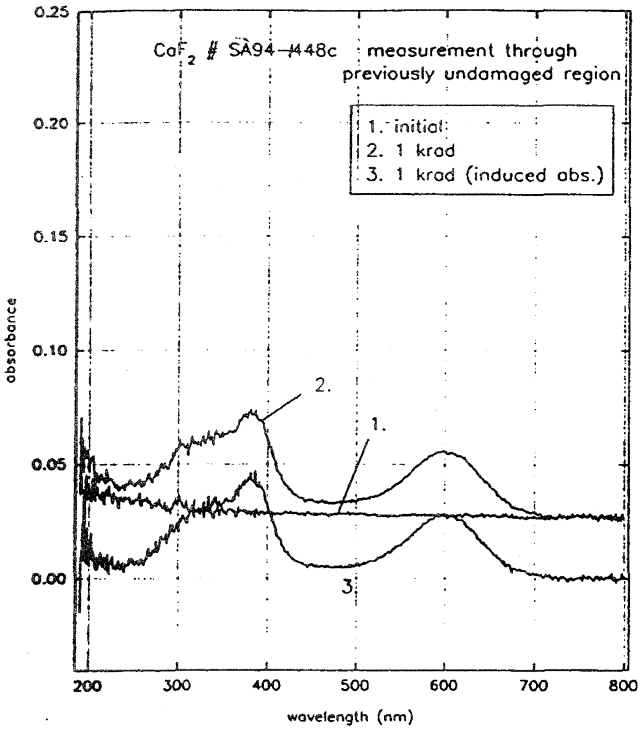
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



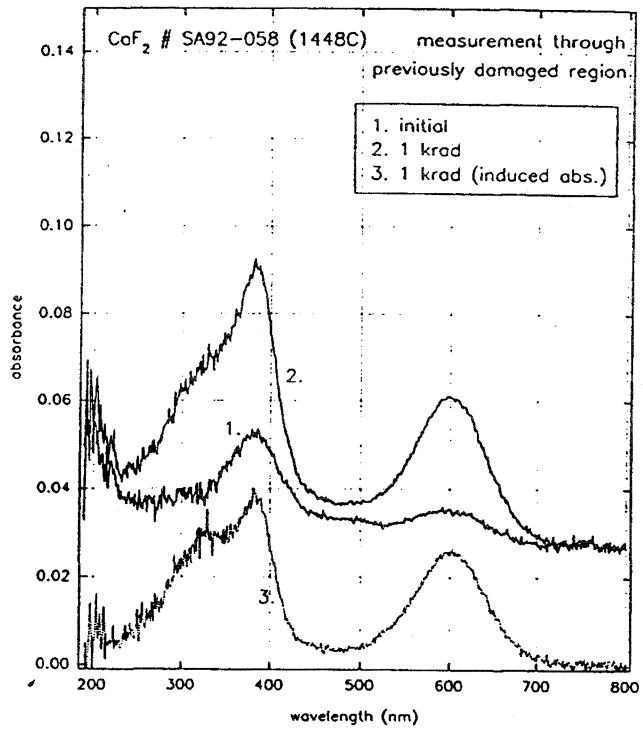
Annotated Wavelengths:

1	Wavelength = 192	Result =	0.024689
2	Wavelength = 194	Result =	0.024041
3	Wavelength = 204	Result =	0.027115
4	Wavelength = 226	Result =	0.021774
5	Wavelength = 330	Result =	0.070484
6	Wavelength = 362	Result =	0.091309
7	Wavelength = 472	Result =	0.021468
8	Wavelength = 582	Result =	0.066452
9	Wavelength = 690	Result =	0.052124
10	Wavelength = 766	Result =	0.003157

CaF_2 1448c (48C)



3-28-95



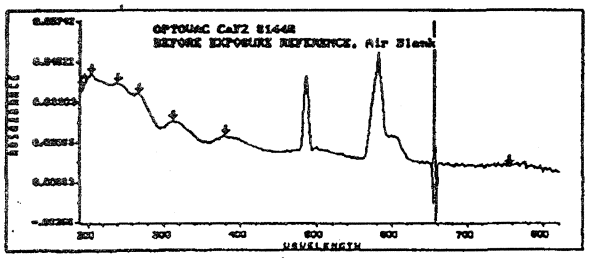
---> WAVELENGTH SCAN REPORT <---

Date : 11-22-1992
Time : 13:48:13
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF1448RF.WAV

Sample Name : CF1448RF
Solvent Name : OP CaF2 1448 RF
Concentration : 0.00E+00
Units : NONE Air Blank

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1	Wavelength = 192	Result =	0.037304
2	Wavelength = 194	Result =	0.038116
3	Wavelength = 204	Result =	0.041450
4	Wavelength = 240	Result =	0.038574
5	Wavelength = 268	Result =	0.035263
6	Wavelength = 312	Result =	0.027116
7	Wavelength = 380	Result =	0.022637
8	Wavelength = 756	Result =	0.013268

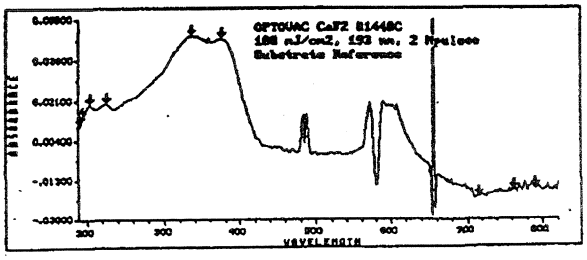
---> WAVELENGTH SCAN REPORT <---

Date : 12-06-1992
Time : 11:54:33
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF1448ZM.WAV

Sample Name : CF1448ZM
Solvent Name : OP CaF2 1448C 2
Concentration : 100.0000
Units : mJ/cm2 Air B 2M

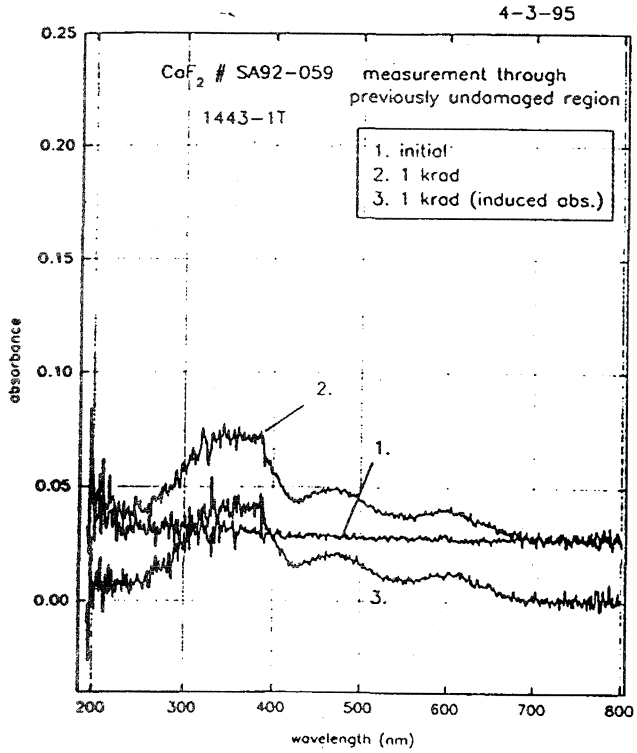
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF

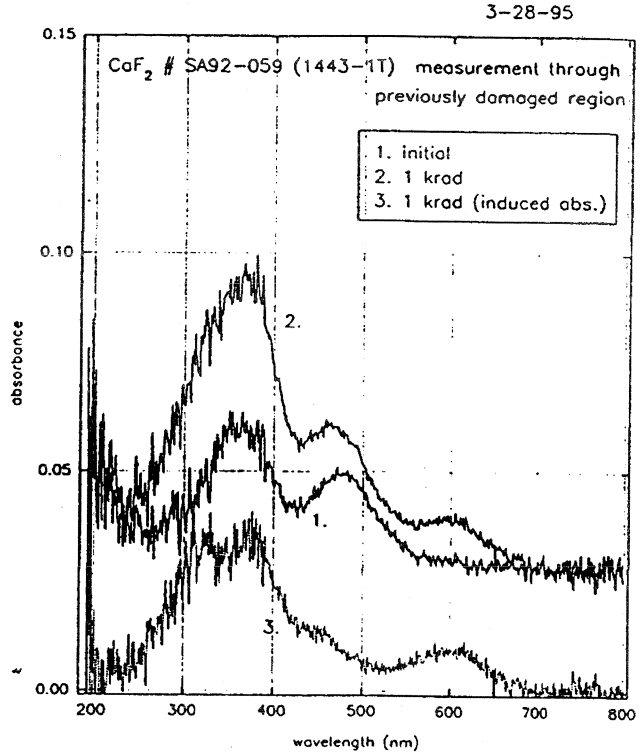


Annotated Wavelengths:

1	Wavelength = 192	Result =	0.011620
2	Wavelength = 194	Result =	0.013515
3	Wavelength = 204	Result =	0.015333
4	Wavelength = 228	Result =	0.019745
5	Wavelength = 336	Result =	0.040254
6	Wavelength = 376	Result =	0.046898
7	Wavelength = 716	Result =	-0.020240
8	Wavelength = 762	Result =	-0.017303
9	Wavelength = 790	Result =	-0.016000

CaF_2 1T (31T)





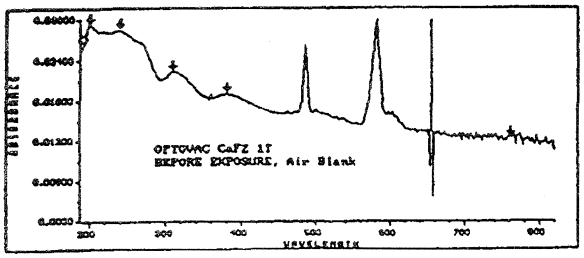
---> WAVELENGTH SCAN REPORT <---

Date : 11-23-1992
Time : 11:09:42
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF1TRF.WAV

Sample Name : CF1TRF
Solvent Name : OP CaF2 1T REF
Concentration : 0.00E+00
Units : NONE Air Blank

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1 : Wavelength = 192 Result = 0.026413
2 : Wavelength = 194 Result = 0.026428
3 : Wavelength = 202 Result = 0.029261
4 : Wavelength = 248 Result = 0.028519
5 : Wavelength = 318 Result = 0.022446
6 : Wavelength = 380 Result = 0.019110
7 : Wavelength = 762 Result = 0.012390

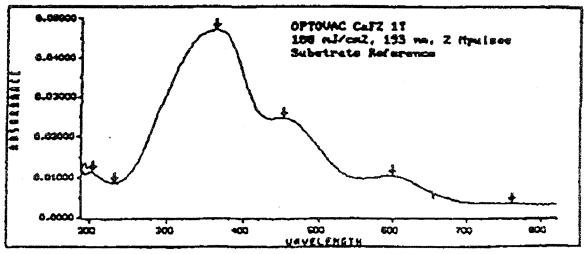
---> WAVELENGTH SCAN REPORT <---

Date : 11-23-1992
Time : 15:32:33
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF1T2MP.WAV

Sample Name : CF1T2MP
Solvent Name : OP CaFZ 1T 2 Mp
Concentration : 100.0000
Units : mJ/cm2 Sub Ref

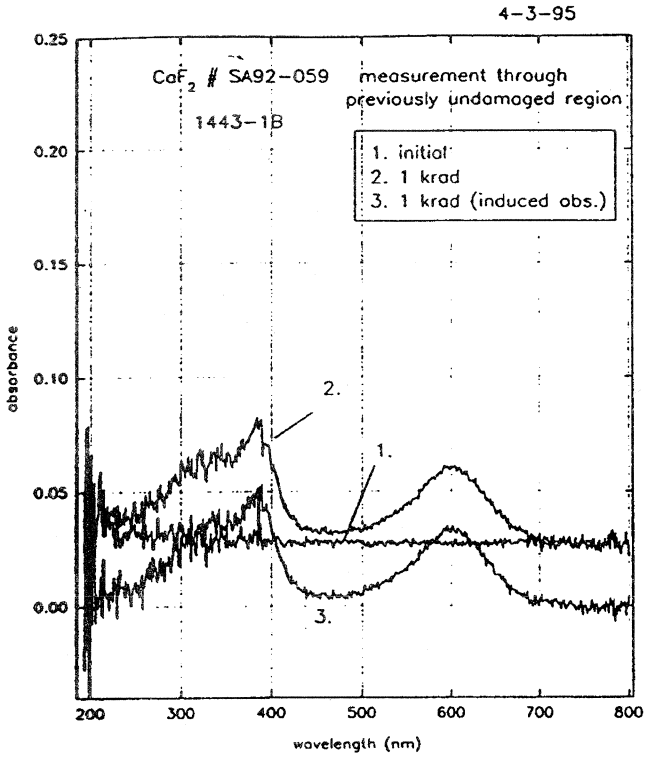
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF

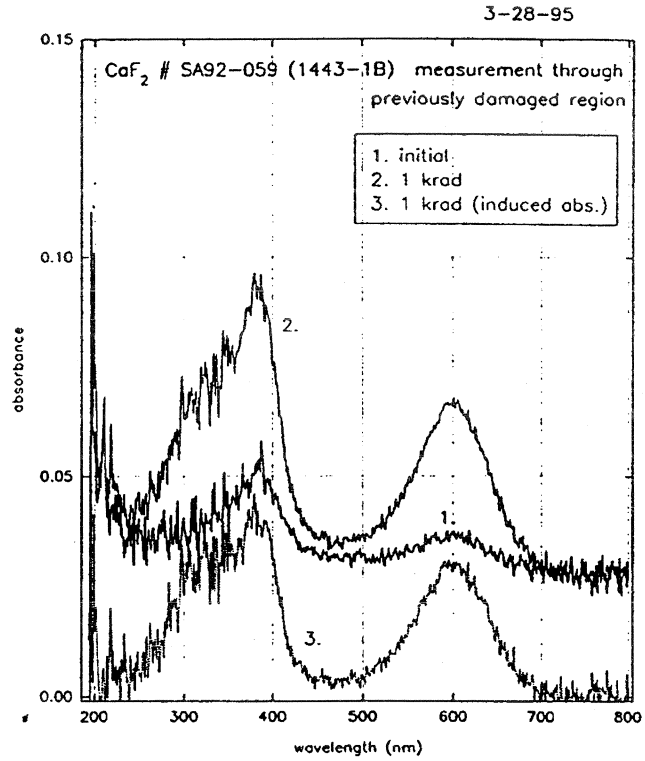


Annotated Wavelengths:

1 : Wavelength = 192 Result = 0.010712
2 : Wavelength = 194 Result = 0.010571
3 : Wavelength = 204 Result = 0.011322
4 : Wavelength = 232 Result = 0.000666
5 : Wavelength = 364 Result = 0.047211
6 : Wavelength = 454 Result = 0.024597
7 : Wavelength = 600 Result = 0.010330
8 : Wavelength = 762 Result = 0.003448

CaF_2 1B (31B)





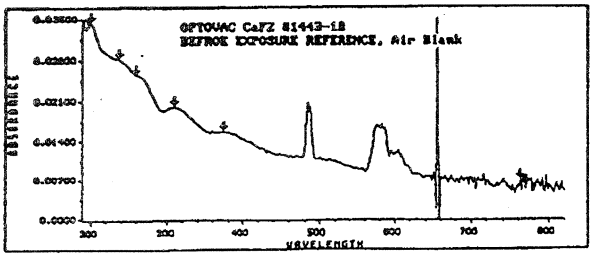
---> WAVELENGTH SCAN REPORT <---

Date : 11-30-1992
Time : 14:45:36
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF18RF.WAV

Sample Name : CF18RF
Solvent Name : OP CaF2 1B REF
Concentration : 0.00E+00
Units : BF EX Air Blank

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1	Wavelength = 192	Result =	0.033157
2	Wavelength = 194	Result =	0.033401
3	Wavelength = 206	Result =	0.034348
4	Wavelength = 238	Result =	0.020244
5	Wavelength = 268	Result =	0.025345
6	Wavelength = 318	Result =	0.020036
7	Wavelength = 374	Result =	0.016666
8	Wavelength = 762	Result =	0.006012
9	Wavelength = 778	Result =	0.006069

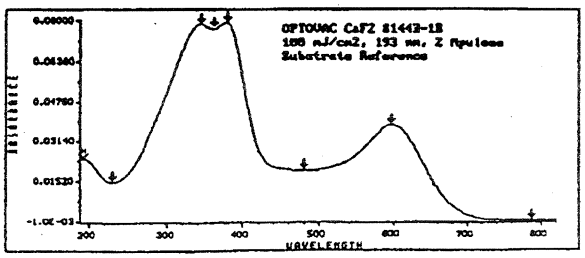
---> WAVELENGTH SCAN REPORT <---

Date : 12-01-1992
Time : 11:24:41
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF182MP.WAV

Sample Name : CF182MP
Solvent Name : OP CaF2 1B 2 Mp
Concentration : 100.0000
Units : mJ/cm2 Sub Ref

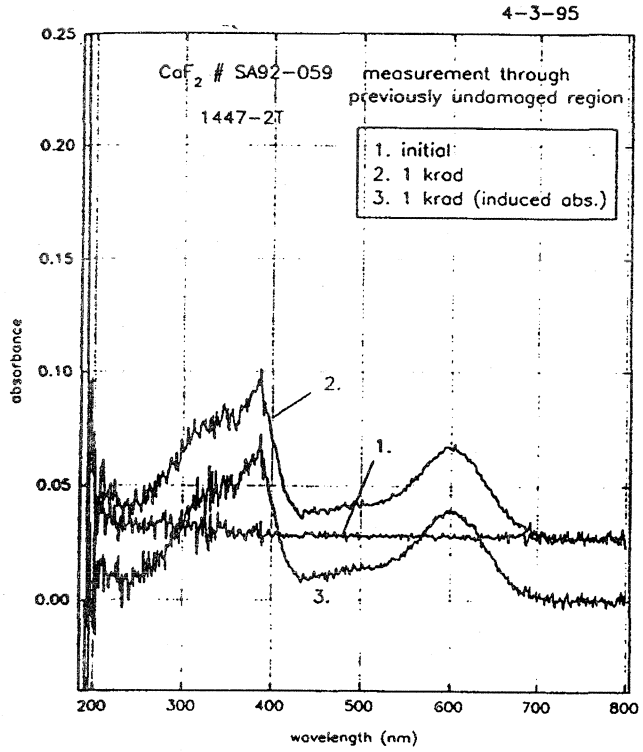
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF

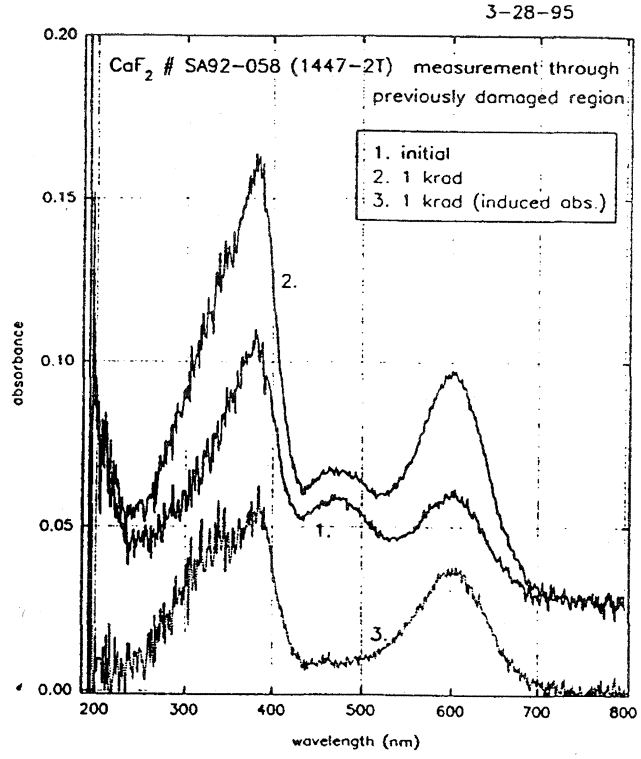


Annotated Wavelengths:

1	Wavelength = 192	Result =	0.024231
2	Wavelength = 194	Result =	0.024040
3	Wavelength = 230	Result =	0.014081
4	Wavelength = 346	Result =	0.070364
5	Wavelength = 362	Result =	0.076736
6	Wavelength = 380	Result =	0.070170
7	Wavelength = 490	Result =	0.019287
8	Wavelength = 598	Result =	0.037964
9	Wavelength = 786	Result =	-0.000549

CaF_2 2T (72T)





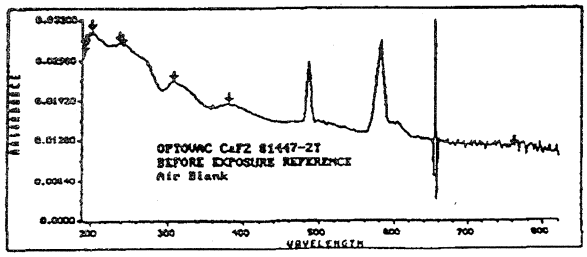
---> WAVELENGTH SCAN REPORT <---

Date : 11-28-1992
Time : 08:54:11
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF2TRF.WAV

Sample Name : CF2TRF
Solvent Name : OP CaF2 2T REF
Concentration : 0.00E+00
Units : BEFORE EXP

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1	Wavelength = 192	Result =	0.026779
2	Wavelength = 194	Result =	0.028168
3	Wavelength = 202	Result =	0.030350
4	Wavelength = 242	Result =	0.028107
5	Wavelength = 238	Result =	0.026583
6	Wavelength = 300	Result =	0.022247
7	Wavelength = 380	Result =	0.018692
8	Wavelength = 762	Result =	0.011734

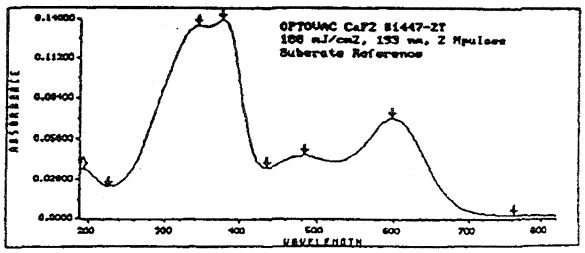
---> WAVELENGTH SCAN REPORT <---

Date : 11-28-1992
Time : 13:51:24
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF2T2MP.WAV

Sample Name : CF2T2MP
Solvent Name : OP CaF2 2T 2 Mp
Concentration : 100.0000
Units : mJ/cm2 Sub REF

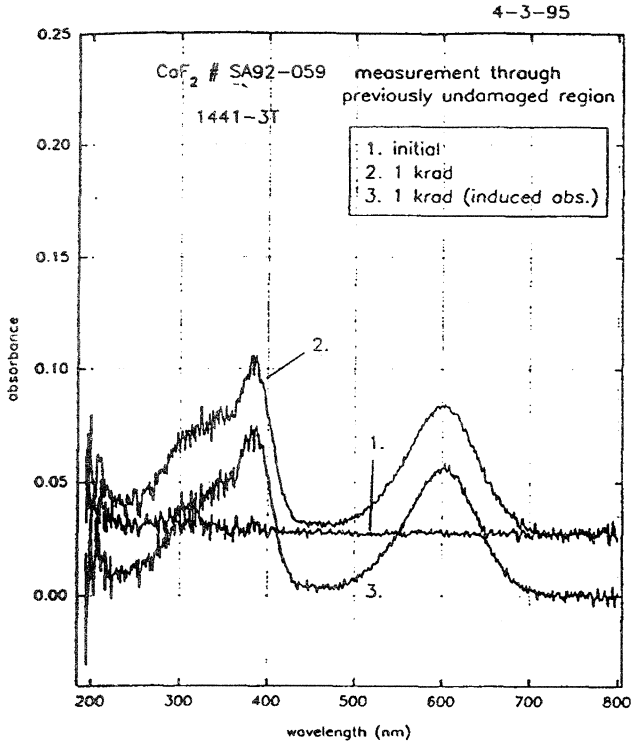
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF

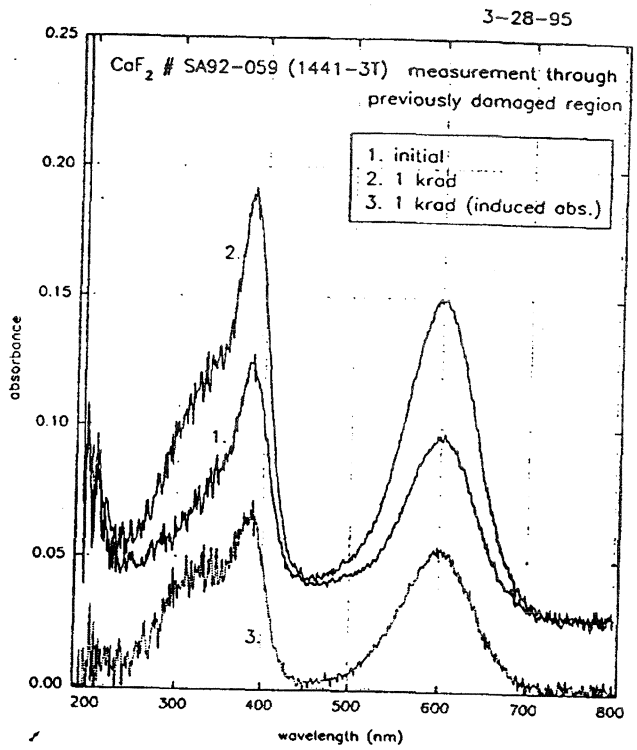


Annotated Wavelengths:

1	Wavelength = 192	Result =	0.035721
2	Wavelength = 194	Result =	0.035567
3	Wavelength = 226	Result =	0.022988
4	Wavelength = 344	Result =	0.136269
5	Wavelength = 376	Result =	0.139313
6	Wavelength = 436	Result =	0.035812
7	Wavelength = 484	Result =	0.044678
8	Wavelength = 598	Result =	0.070114
9	Wavelength = 762	Result =	0.002075

CaF_2 3T (13T)





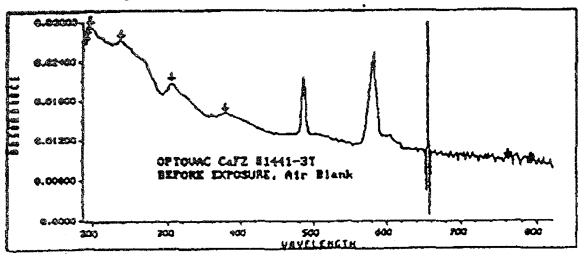
---> WAVELENGTH SCAN REPORT <---

Date : 11-28-1992
Time : 14:34:38
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF3TRF.WAV

Sample Name : CF3TRF
Solvent Name : OP CaF2 3T REF
Concentration : 0.00E+00
Units : BEFORE EXP

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1	Wavelength = 192	Result =	0.026779
2	Wavelength = 194	Result =	0.027606
3	Wavelength = 198	Result =	0.025287
4	Wavelength = 230	Result =	0.027222
5	Wavelength = 306	Result =	0.020645
6	Wavelength = 378	Result =	0.015901
7	Wavelength = 762	Result =	0.009010
8	Wavelength = 792	Result =	0.008459

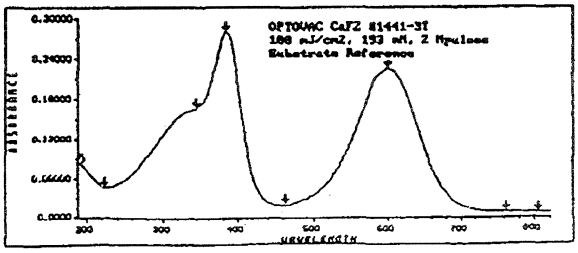
---> WAVELENGTH SCAN REPORT <---

Date : 11-30-1992
Time : 11:44:40
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF3T2MP.WAV

Sample Name : CF3T2MP
Solvent Name : OP CaF2 3T 2Mp
Concentration : 100.0000
Units : mJ/cm2 Sub Ref

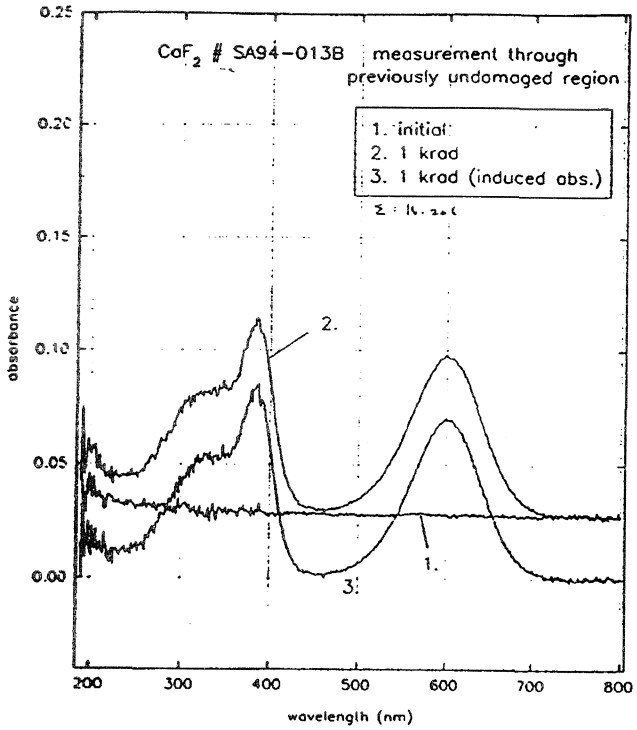
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF

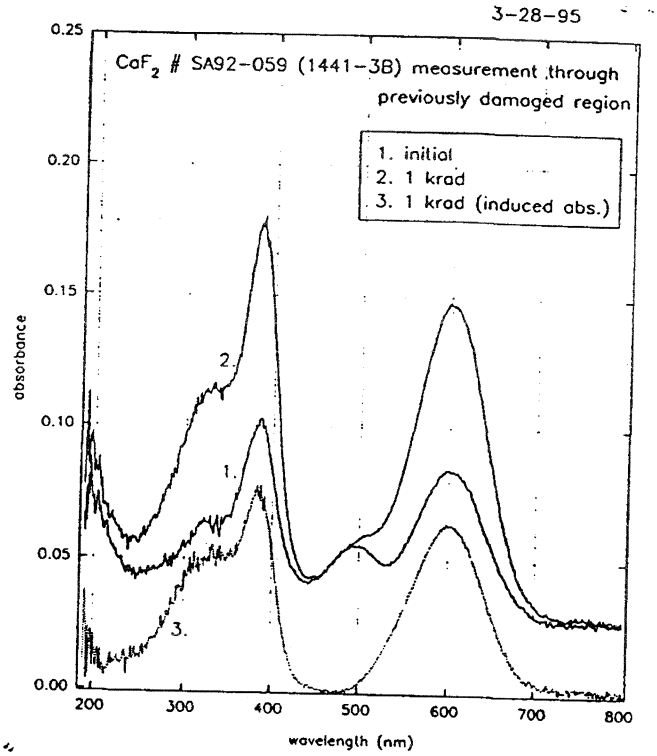


Annotated Wavelengths:

1	Wavelength = 192	Result =	0.003527
2	Wavelength = 194	Result =	0.001879
3	Wavelength = 224	Result =	0.047333
4	Wavelength = 344	Result =	0.166382
5	Wavelength = 384	Result =	0.200106
6	Wavelength = 462	Result =	0.019485
7	Wavelength = 600	Result =	0.225311
8	Wavelength = 804	Result =	0.007370
9	Wavelength = 762	Result =	0.008240

CaF_2 3B (13B)



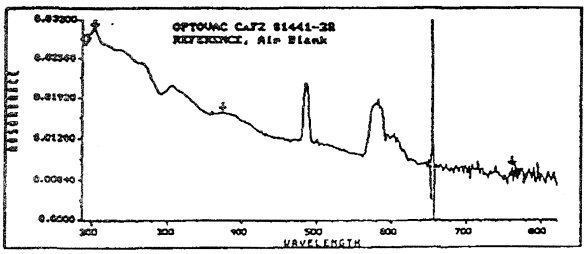


---> WAVELENGTH SCAN REPORT <---

Date : 11-30-1992
Time : 11:52:35
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF38RF.WAV

Sample Name	: CF38RF	Function	: Absorbance
Solvent Name	: OP CaF2 3B REF	Wavelength Range	: 190 to 820 nanometers
Concentration	: 0.00E+00	Integration Time	: 1 seconds
Units	: BF EX Air Blank	Std Deviation	: OFF



Annotated Wavelengths:

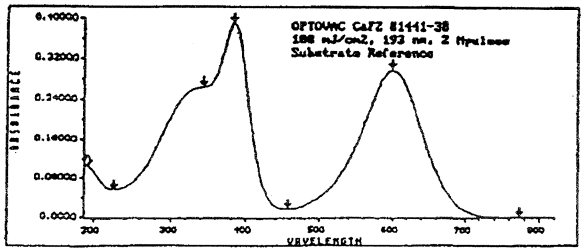
1 :	Wavelength = 192	Result =	0.027710
2 :	Wavelength = 194	Result =	0.028187
3 :	Wavelength = 204	Result =	0.030366
4 :	Wavelength = 374	Result =	0.016730
5 :	Wavelength = 762	Result =	0.000224
6 :	Wavelength = 788	Result =	0.000393

---> WAVELENGTH SCAN REPORT <---

Date : 11-30-1992
Time : 11:58:29
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF382MP.WAV

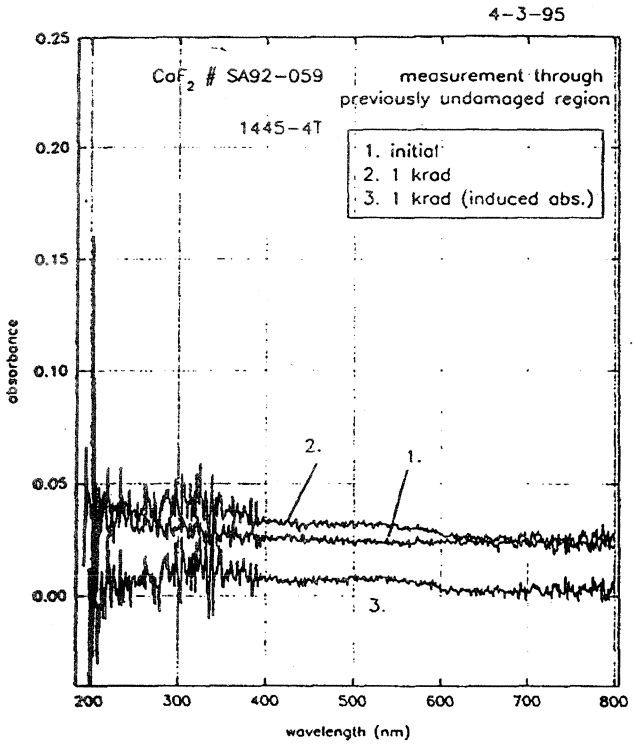
Sample Name	: CF382MP	Function	: Absorbance
Solvent Name	: OP CaF2 3B 2Mp	Wavelength Range	: 190 to 820 nanometers
Concentration	: 100.0000	Integration Time	: 1 seconds
Units	: mJ/cm2 Sub Ref	Std Deviation	: OFF

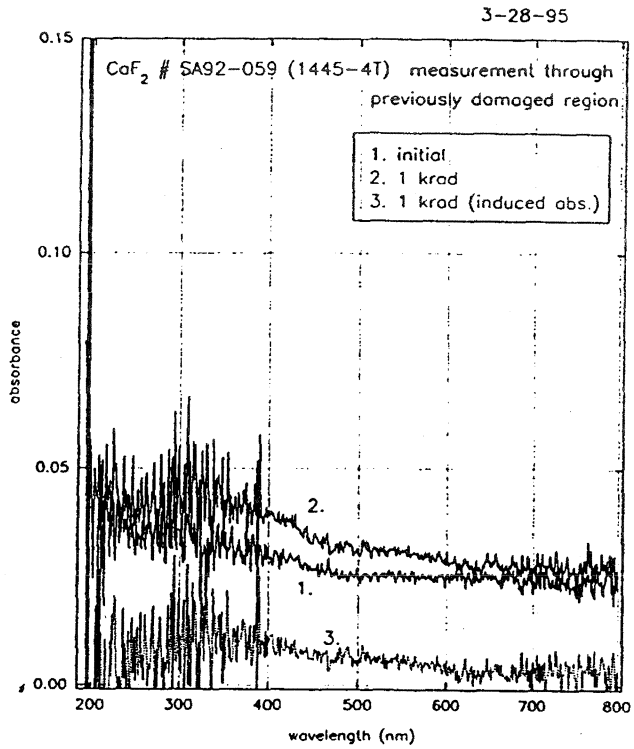


Annotated Wavelengths:

1 :	Wavelength = 192	Result =	0.186491
2 :	Wavelength = 194	Result =	0.184385
3 :	Wavelength = 226	Result =	0.056237
4 :	Wavelength = 344	Result =	0.263382
5 :	Wavelength = 384	Result =	0.388702
6 :	Wavelength = 458	Result =	0.015121
7 :	Wavelength = 600	Result =	0.296310
8 :	Wavelength = 774	Result =	0.000244

CaF_2 4T (54T)





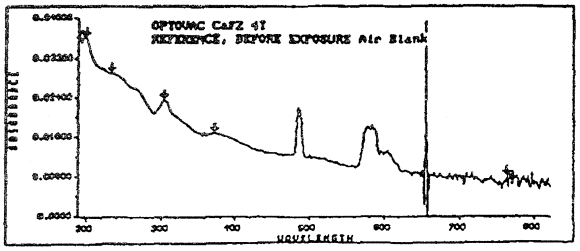
---> WAVELENGTH SCAN REPORT <---

Date : 12-01-1992
Time : 11:42:38
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF4TRF.UAV

Sample Name : CF4TRF
Solvent Name : OP CaF2 4T REF
Concentration : 0.00E+00
Units : BF EX Air Blank

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1 :	Wavelength = 192	Result =	0.035080
2 :	Wavelength = 194	Result =	0.035461
3 :	Wavelength = 200	Result =	0.036087
4 :	Wavelength = 234	Result =	0.029022
5 :	Wavelength = 364	Result =	0.023463
6 :	Wavelength = 372	Result =	0.016626
7 :	Wavelength = 762	Result =	0.007828
8 :	Wavelength = 770	Result =	0.006851

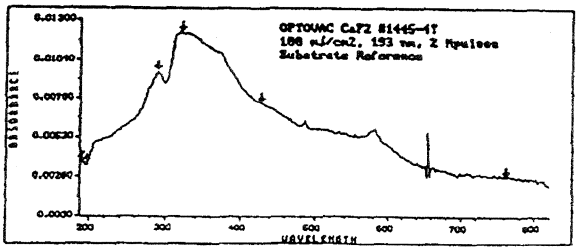
---> WAVELENGTH SCAN REPORT <---

Date : 12-01-1992
Time : 15:00:07
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF4T2MP.UAV

Sample Name : CF4T2MP
Solvent Name : OP CaF2 4T 2Mp
Concentration : 100.0000
Units : mJ/cm2 Sub Ref

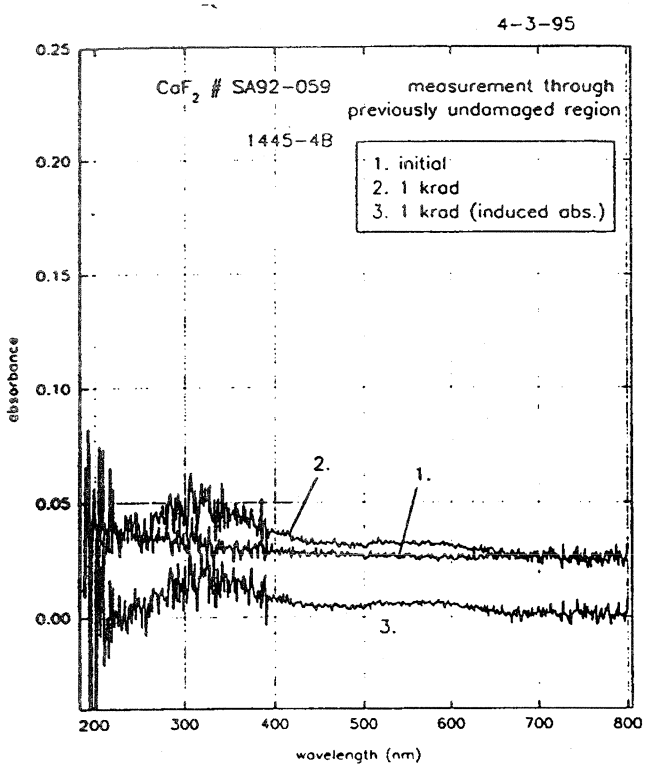
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF

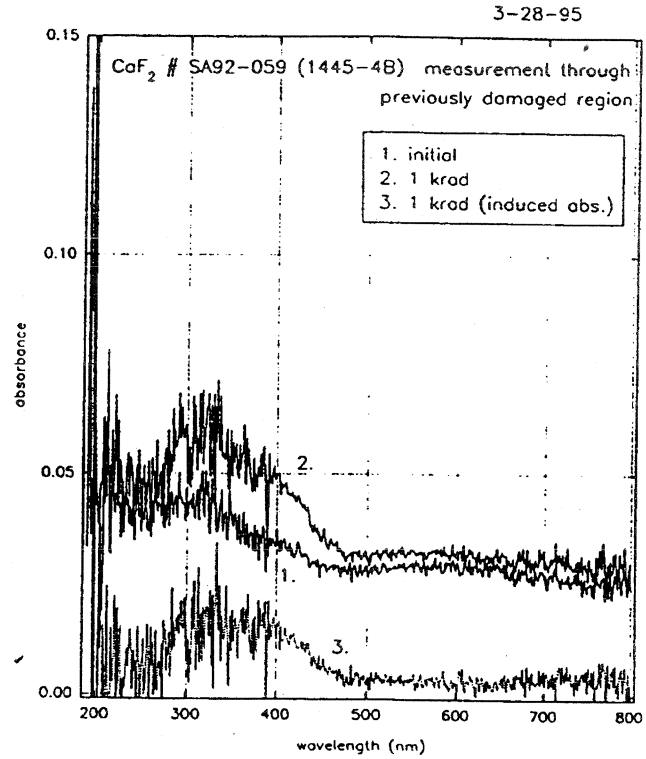


Annotated Wavelengths:

1 :	Wavelength = 192	Result =	0.003555
2 :	Wavelength = 194	Result =	0.003326
3 :	Wavelength = 196	Result =	0.003357
4 :	Wavelength = 290	Result =	0.005598
5 :	Wavelength = 322	Result =	0.012161
6 :	Wavelength = 428	Result =	0.007481
7 :	Wavelength = 762	Result =	0.002563

CaF_2 4B (54B)





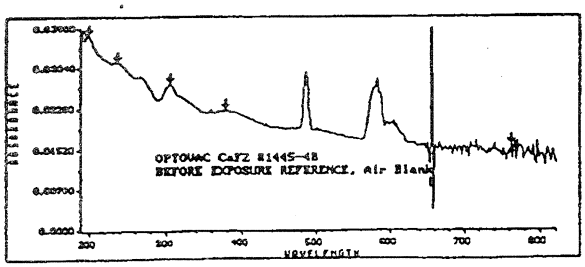
---> WAVELENGTH SCAN REPORT <---

Date : 12-02-1992
Time : 08:26:32
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF4BRF.UAV

Sample Name : CF4BRF
Solvent Name : OP CaF2 4B REF
Concentration : 0.00E+00
Units : BF EX Air Blank

Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



Annotated Wavelengths:

1 : Wavelength = 192	Result =	0.036706
2 : Wavelength = 194	Result =	0.035904
3 : Wavelength = 200	Result =	0.036602
4 : Wavelength = 238	Result =	0.031626
5 : Wavelength = 308	Result =	0.027512
6 : Wavelength = 378	Result =	0.022614
7 : Wavelength = 762	Result =	0.015976
8 : Wavelength = 770	Result =	0.014587

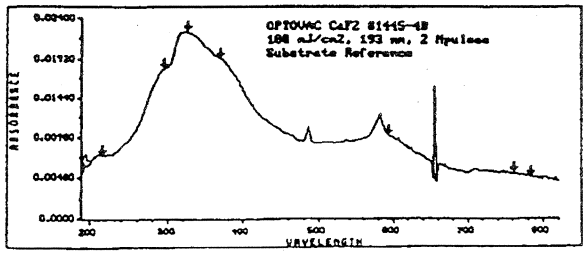
---> WAVELENGTH SCAN REPORT <---

Date : 12-02-1992
Time : 13:00:32
Operator : JAN SEDLACEK

File Name : C:\UV\SEDLACEK\OPTOVAC\CF4B2MP.UAV

Sample Name : CF4B2MP
Solvent Name : OP CaF2 4B 2 Mp
Concentration : 100.0000
Units : mJ/cm2 Sub Ref

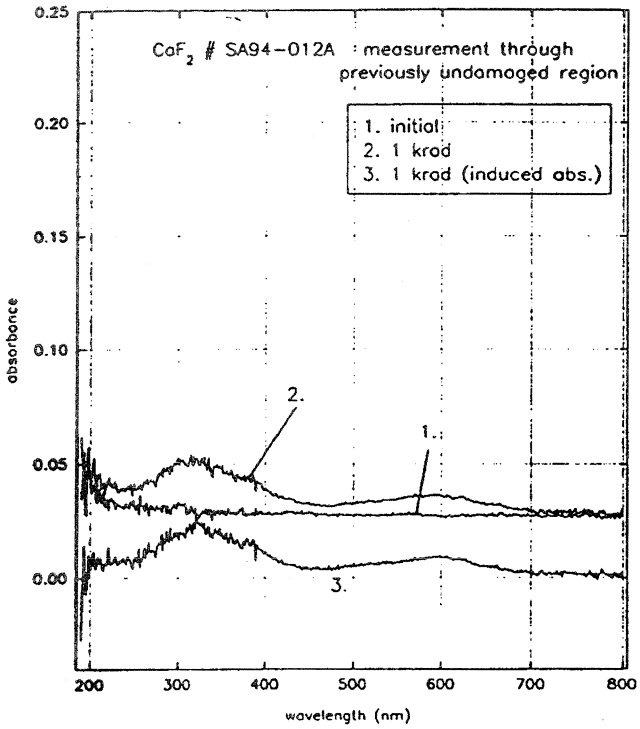
Function : Absorbance
Wavelength Range : 190 to 820 nanometers
Integration Time : 1 seconds
Std Deviation : OFF



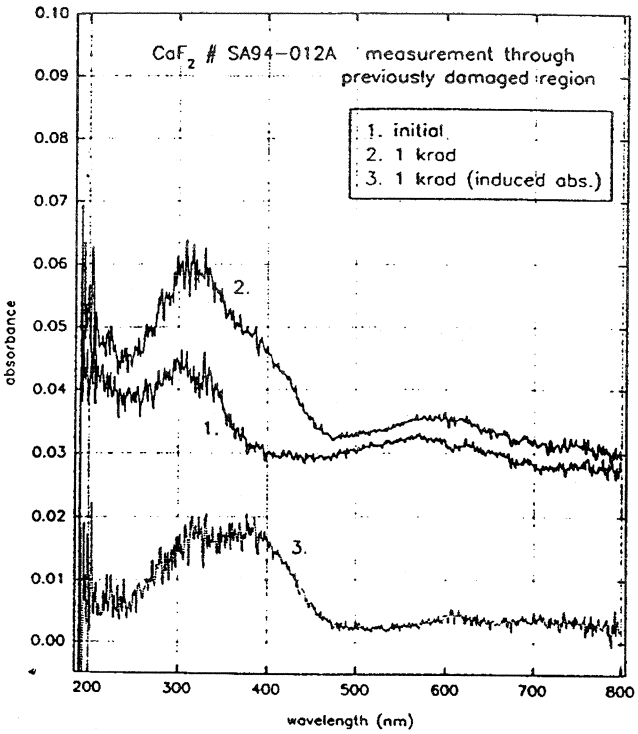
Annotated Wavelengths:

1 : Wavelength = 192	Result =	0.006012
2 : Wavelength = 194	Result =	0.006134
3 : Wavelength = 216	Result =	0.007355
4 : Wavelength = 296	Result =	0.017950
5 : Wavelength = 326	Result =	0.022354
6 : Wavelength = 370	Result =	0.019241
7 : Wavelength = 594	Result =	0.008674
8 : Wavelength = 762	Result =	0.005249
9 : Wavelength = 784	Result =	0.004822

CaF_2 012A



3-28-95



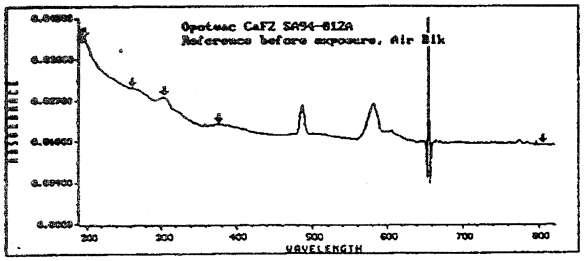
---> WAVELENGTH SCAN REPORT <---

Date : 04-12-1994
Time : 08:46:33
Operator : Jan Sedlacek

File Name : CF12AREF.WAV Register: A

Sample Name : cf12aref CaF2
Solvent Name : SA94012A Bf Ref
Concentration : 0.0000
Units : Air Ref

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.03987
Reg A: L 194 - 0.04063
Reg A: L 196 - 0.04065
Reg A: L 262 - 0.02971
Reg A: L 304 - 0.02700
Reg A: L 376 - 0.02188
Reg A: L 804 - 0.01720

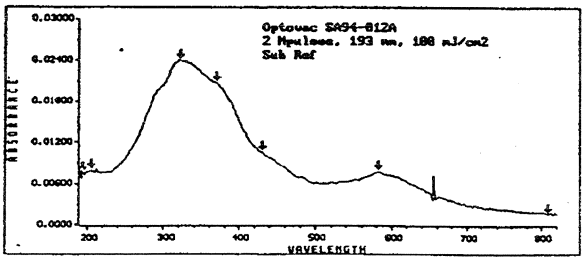
---> WAVELENGTH SCAN REPORT <---

Date : 04-12-1994
Time : 13:07:17
Operator : Jan Sedlacek

File Name : CF12A2MP.WAV Register: A

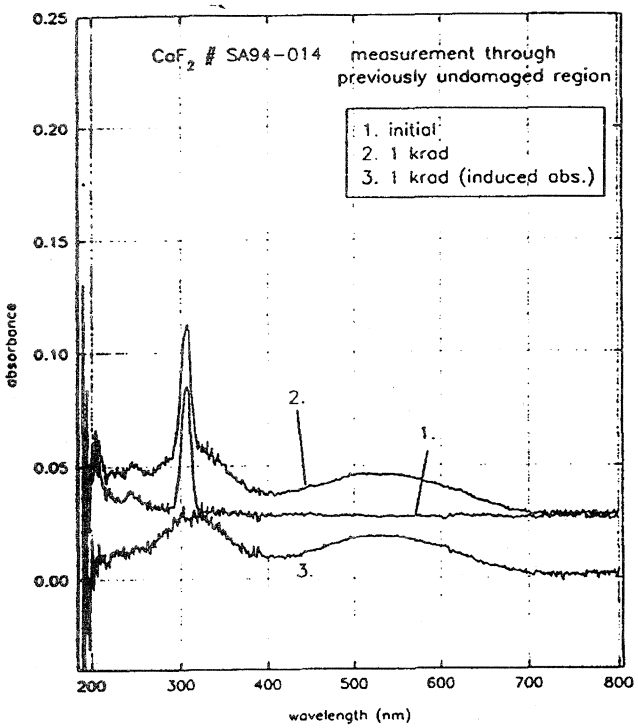
Sample Name : cf12a2mp CaF2
Solvent Name : SA9412A 2 Mpul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off

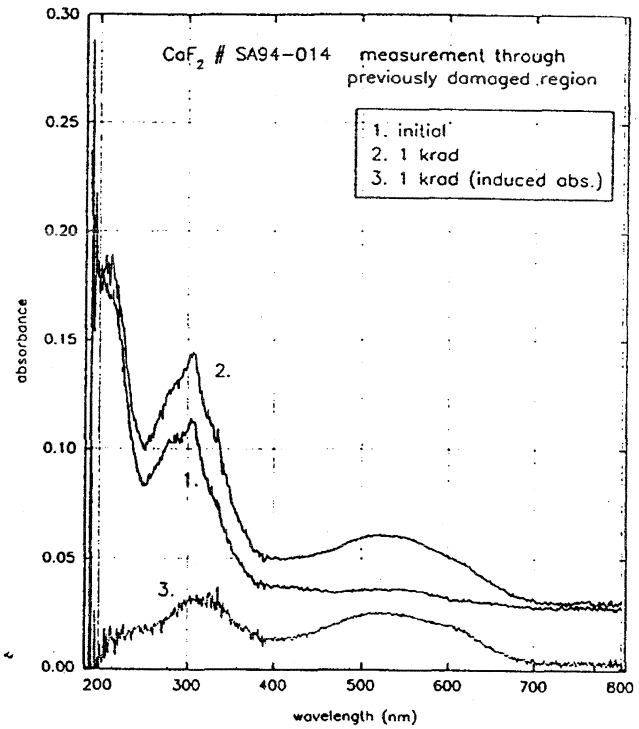


Marked Wavelengths
Reg A: L 192 - 0.00673
Reg A: L 194 - 0.00761
Reg A: L 206 - 0.00800
Reg A: L 322 - 0.02399
Reg A: L 370 - 0.02069
Reg A: L 430 - 0.01051
Reg A: L 582 - 0.00771
Reg A: L 800 - 0.00156

CaF_2 14



3-28-95



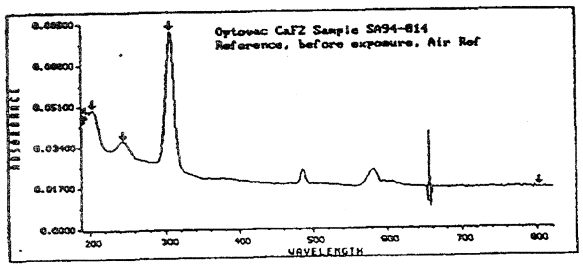
---> WAVELENGTH SCAN REPORT <---

Date : 04-19-1994
Time : 08:58:32
Operator : Jan Sedlacek

File Name : CF14REF.WAV
Register: A

Sample Name : cf14ref CaF2
Solvent Name : SA94014 8f exp
Concentration : 0.0000
Units : Air Ref

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.04419
Reg A: L 194 - 0.04636
Reg A: L 204 - 0.04951
Reg A: L 244 - 0.03656
Reg A: L 306 - 0.08167
Reg A: L 802 - 0.01590

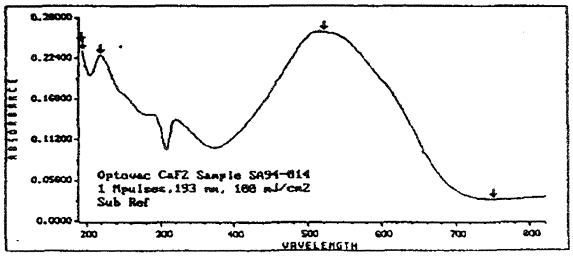
---> WAVELENGTH SCAN REPORT <---

Date : 04-19-1994
Time : 11:18:32
Operator : Jan Sedlacek

File Name : CF141MP.WAV
Register: A

Sample Name : cf141mp CaF2
Solvent Name : SA94014 1 Mpul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.24530
Reg A: L 194 - 0.23311
Reg A: L 210 - 0.22816
Reg A: L 522 - 0.26824
Reg A: L 752 - 0.02937

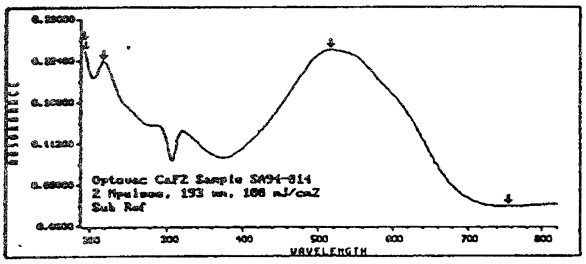
---> WAVELENGTH SCAN REPORT <---

Date : 04-19-1994
Time : 13:25:37
Operator : Jan Sedlacek

File Name : CF142MP.WAV Register: A

Sample Name : cf142mp CaF2
Solvent Name : SAS4014 2 Mpul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.24966
Reg A: L 194 - 0.23595
Reg A: L 218 - 0.22359
Reg A: L 516 - 0.23851
Reg A: L 756 - 0.02637

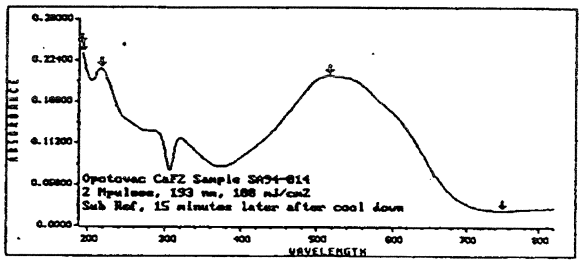
---> WAVELENGTH SCAN REPORT <---

Date : 04-19-1994
Time : 13:43:06
Operator : Jan Sedlacek

File Name : CF142MPB.WAV Register: A

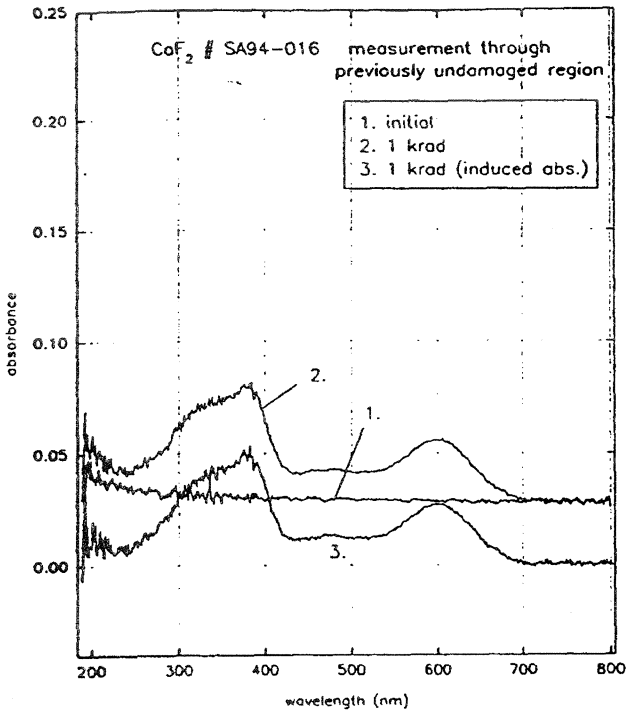
Sample Name : cf142mpb CoolDn
Solvent Name : SAS4014 2 Mpul
Concentration : 100.00
Units : SR scanB

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off

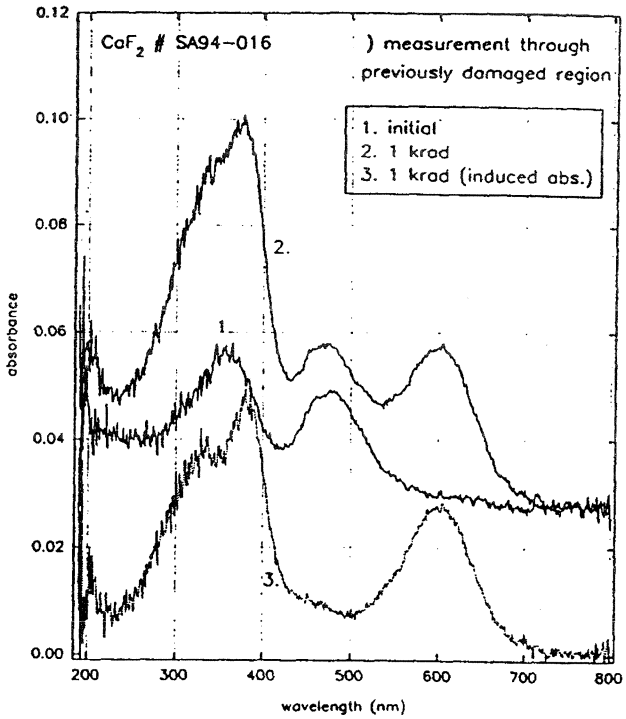


Marked Wavelengths
Reg A: L 192 - 0.24564
Reg A: L 194 - 0.23325
Reg A: L 218 - 0.21385
Reg A: L 518 - 0.20354
Reg A: L 750 - 0.02173

CaF_2 16



3-28-95



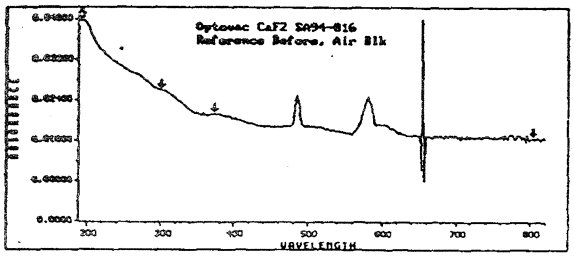
---> WAVELENGTH SCAN REPORT <---

Date : 04-13-1994
Time : 09:29:46
Operator : Jan Sedlacek

File Name : CF16REF.WAV
Register: A

Sample Name : cf16ref CaF2
Solvent Name : SA9416 beforeRf
Concentration : 0.0000
Units : Air Ref

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.03934
Reg A: L 194 - 0.03992
Reg A: L 302 - 0.02594
Reg A: L 374 - 0.02115
Reg A: L 804 - 0.01630

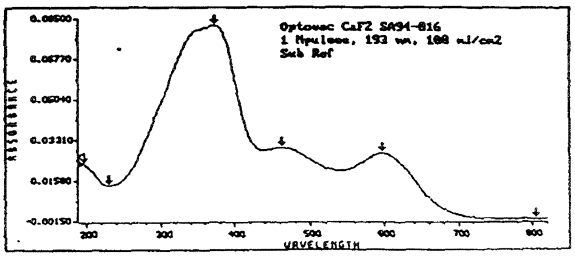
---> WAVELENGTH SCAN REPORT <---

Date : 04-13-1994
Time : 11:51:34
Operator : Jan Sedlacek

File Name : CF16IMP.WAV
Register: A

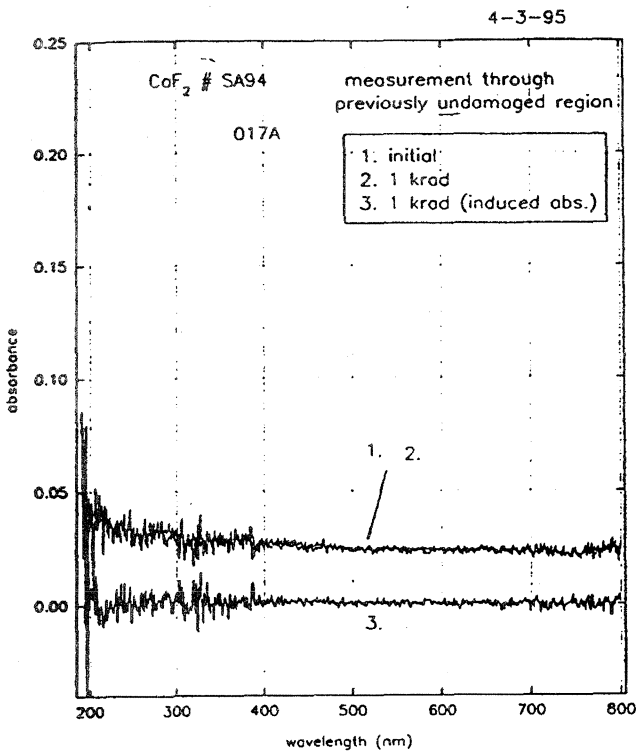
Sample Name : cf16imp CaF2
Solvent Name : SA9416 1 Mpul
Concentration : 100.00
Units : mJ SubRf

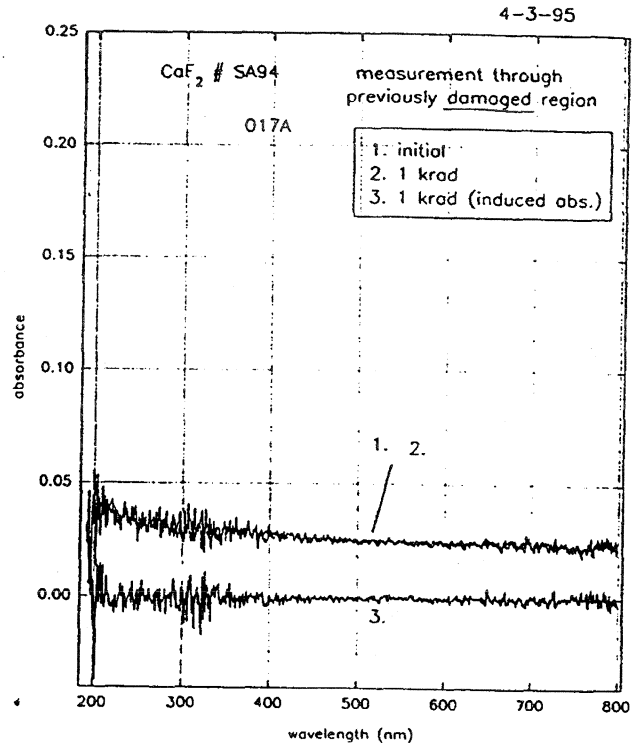
Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.02257
Reg A: L 194 - 0.02290
Reg A: L 196 - 0.02301
Reg A: L 230 - 0.01381
Reg A: L 372 - 0.00209
Reg A: L 462 - 0.02982
Reg A: L 590 - 0.02725
Reg A: L 804 - -5.3E-04

CaF_2 17A





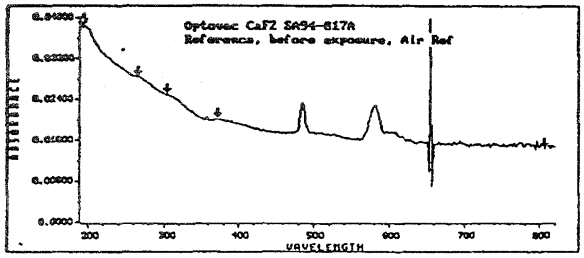
---> WAVELENGTH SCAN REPORT <---

Date : 04-14-1994
Time : 09:06:33
Operator : Jan Sedlacek

File Name : CF17AREF.WAV Register: A

Sample Name : cf17aref CaF2
Solvent Name : SA94017A BfRef
Concentration : 0.0000
Units : Air Ref

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.03801
Reg A: L 194 - 0.03860
Reg A: L 266 - 0.02843
Reg A: L 304 - 0.02490
Reg A: L 372 - 0.02014
Reg A: L 806 - 0.01421

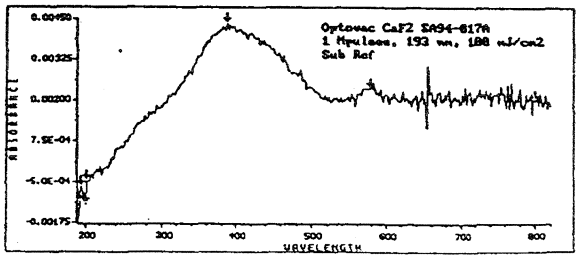
---> WAVELENGTH SCAN REPORT <---

Date : 04-14-1994
Time : 11:57:40
Operator : Jan Sedlacek

File Name : CF17AIMP.WAV Register: A

Sample Name : cf17aimp CaF2
Solvent Name : SA94017A 1 Mpul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - -0.00111
Reg A: L 194 - -6.4E-04
Reg A: L 200 - -0.00119
Reg A: L 202 - -4.7E-04
Reg A: L 308 - 0.00435
Reg A: L 578 - 0.00237
Reg A: L 800 - 0.00201

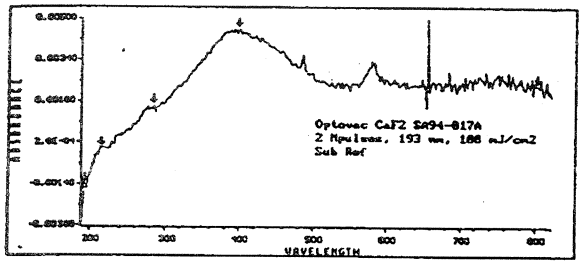
---> WAVELENGTH SCAN REPORT <---

Date : 04-14-1994
Time : 14:03:01
Operator : Jan Sedlacek

File Name : CF17A2MP.WAV Register: A

Sample Name : cf17a2mp CaF2
Solvent Name : SA94017A 2 Mpul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - -0.00174
Reg A: L 194 - -0.00140
Reg A: L 216 - -3.1E-05
Reg A: L 284 - 0.00165
Reg A: L 390 - 0.00462
Reg A: L 802 - 0.00244

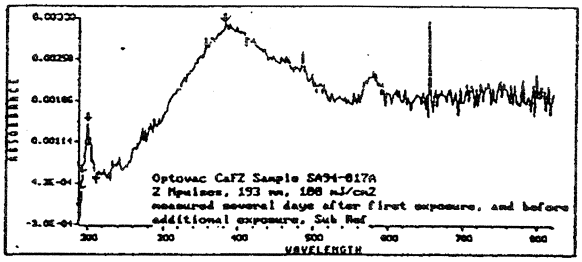
---> WAVELENGTH SCAN REPORT <---

Date : 04-20-1994
Time : 09:46:55
Operator : Jan Sedlacek

File Name : CF17A2ML.WAV Register: A

Sample Name : cf17a2ml CaF2
Solvent Name : SA94017a 2Mplsl
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 2.6E-04
Reg A: L 194 - 5.6E-04
Reg A: L 200 - 0.00146
Reg A: L 212 - 4.1E-04
Reg A: L 382 - 0.00319
Reg A: L 804 - 0.00192

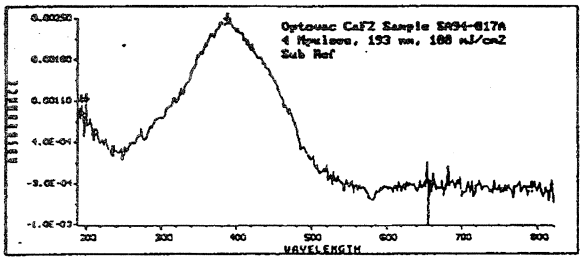
---> WAVELENGTH SCAN REPORT <---

Date : 04-20-1994
Time : 13:40:45
Operator : Jan Sedlacek

File Name : CF17A4MP.WAV Register: A

Sample Name : cf17a4mp CaF2
Solvent Name : SA94017a 4 Mpul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 7.9E-04
Reg A: L 194 - 0.00164
Reg A: L 200 - 0.00185
Reg A: L 236 - 1.7E-04
Reg A: L 308 - 0.00240
Reg A: L 792 - -4.4E-04

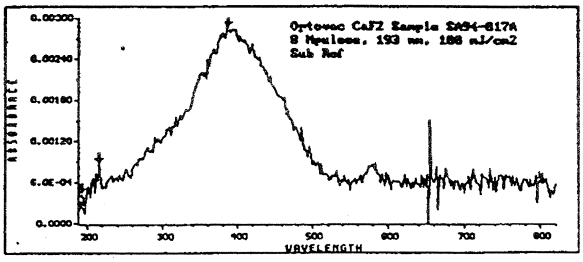
---> WAVELENGTH SCAN REPORT <---

Date : 04-21-1994
Time : 17:07:53
Operator : Jan Sedlacek

File Name : CF17A8MP.WAV Register: A

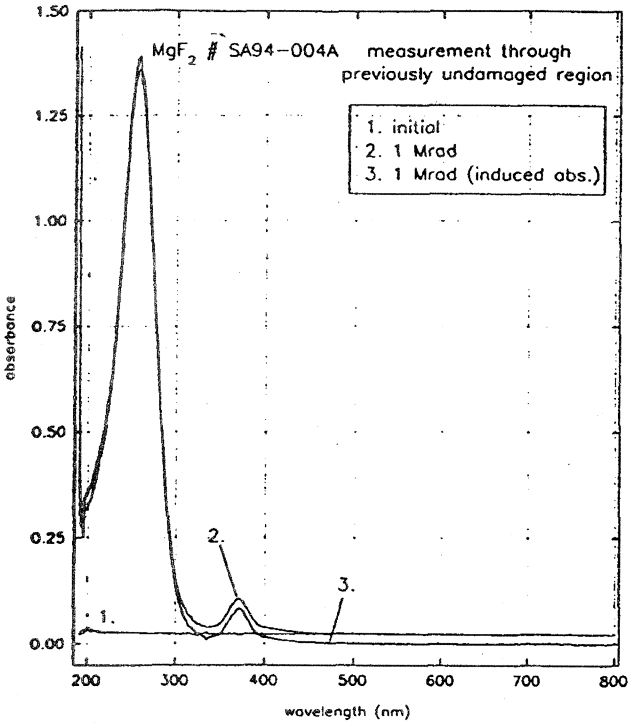
Sample Name : cf17a8mp CaF2
Solvent Name : SA94017A 8 Mpul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off

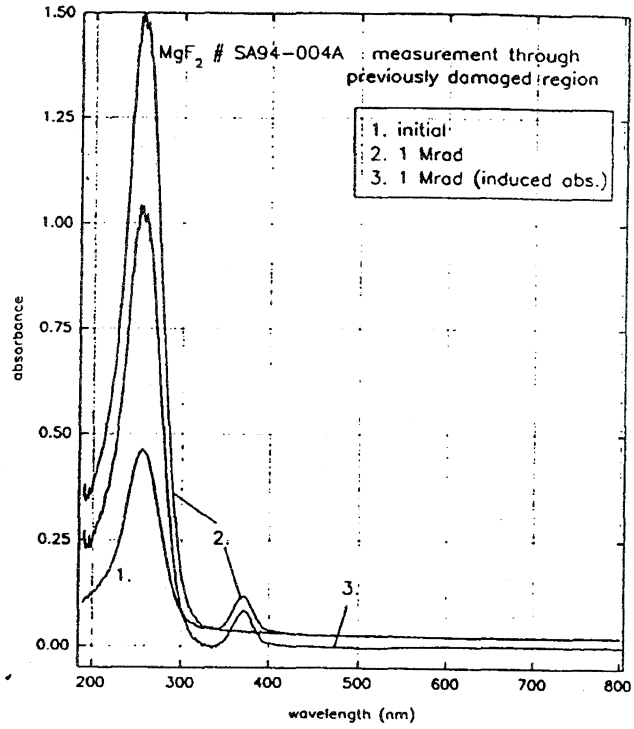


Marked Wavelengths
Reg A: L 192 - 4.3E-04
Reg A: L 194 - 2.3E-04
Reg A: L 216 - 8.7E-04
Reg A: L 388 - 0.00285
Reg A: L 802 - 5.6E-04

MgF_2 04A



4-20-95



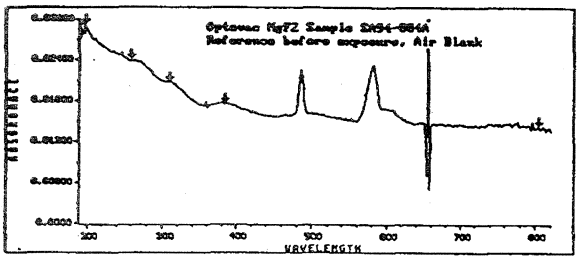
---> WAVELENGTH SCAN REPORT <---

Date : 05-27-1994
Time : 10:39:36
Operator : Jan Sedlacek

File Name : SA944ARF.WAV Register: A

Sample Name : sa944arf MgF24A
Solvent Name : SA94004A Ref
Concentration : 0.0000
Units : Air Ref

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.02769
Reg A: L 194 - 0.02614
Reg A: L 198 - 0.02311
Reg A: L 260 - 0.02379
Reg A: L 310 - 0.02063
Reg A: L 384 - 0.01740
Reg A: L 664 - 0.01408

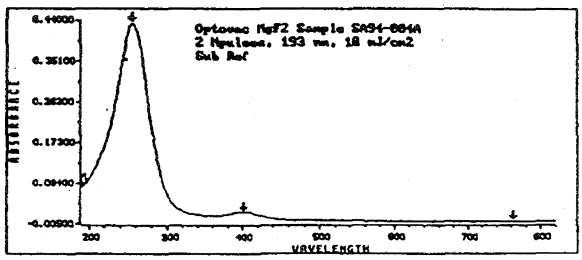
---> WAVELENGTH SCAN REPORT <---

Date : 05-27-1994
Time : 15:01:23
Operator : Jan Sedlacek

File Name : SA944A2M.WAV Register: A

Sample Name : sa944a2m MgF24A
Solvent Name : SA94-4A 2 Mpuls
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off

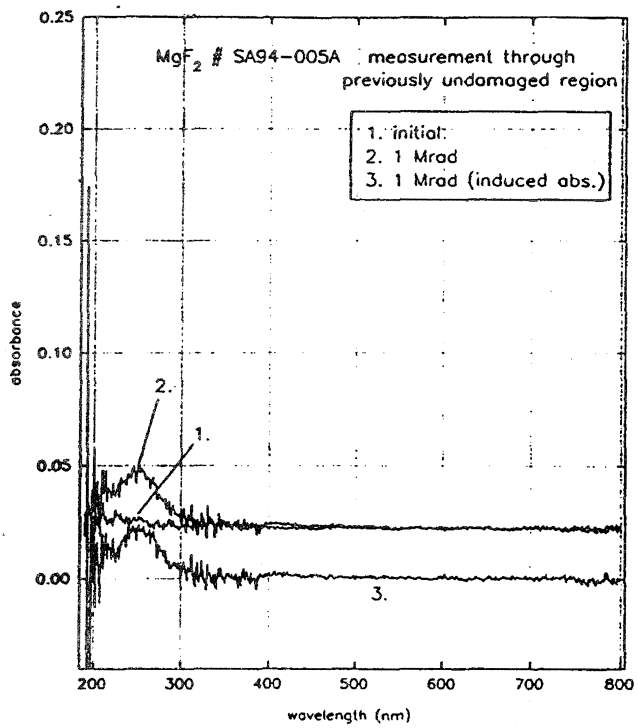


2 Mpulses

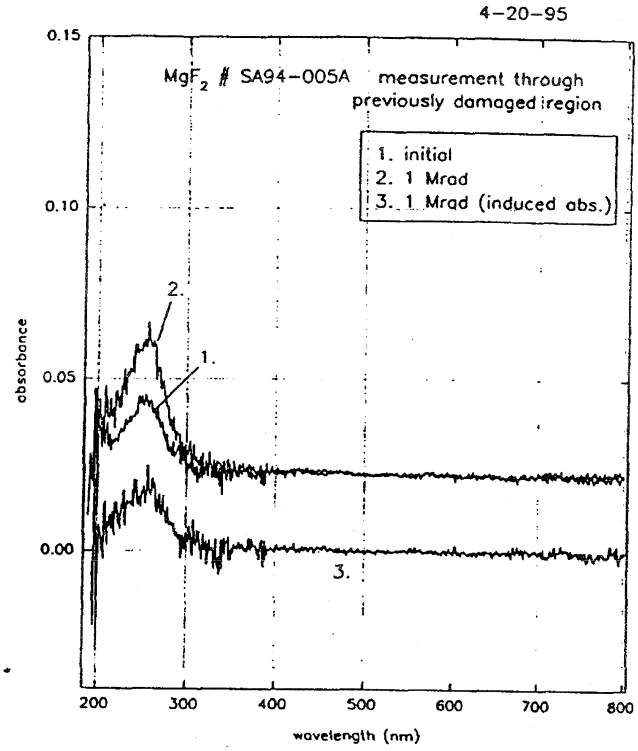
Marked Wavelengths
Reg A: L 192 - 0.07782 > 0.080
Reg A: L 194 - 0.08096
Reg A: L 256 - 0.43427 0.434
Reg A: L 402 - 0.02115
Reg A: L 764 - 9.5E-04 0.001

Δ 193nm = 0.079/cm
Δ 256nm = 0.433/cm

MgF_2 05A



4-20-95



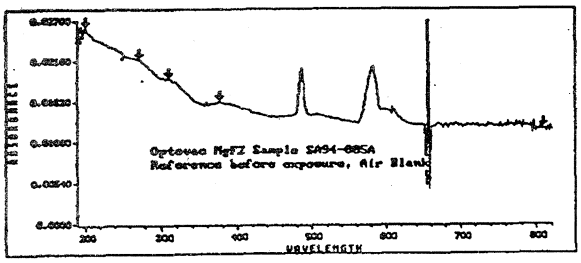
---> WAVELENGTH SCAN REPORT <---

Date : 05-28-1994
Time : 11:00:39
Operator : Jan Sedlacek

File Name : SA94SARF.WAV
Register: A

Sample Name : se94Serf MgF2SA
Solvent Name : SA94 SA Ref BfE
Concentration : 0.0000
Units : Air Blk

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.02411
Reg A: L 194 - 0.02483
Reg A: L 200 - 0.02608
Reg A: L 272 - 0.02191
Reg A: L 310 - 0.01527
Reg A: L 376 - 0.01616
Reg A: L 808 - 0.01262

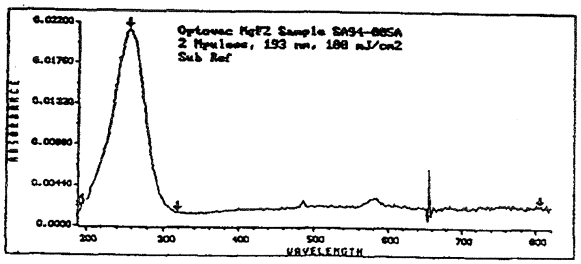
---> WAVELENGTH SCAN REPORT <---

Date : 05-28-1994
Time : 15:13:29
Operator : Jan Sedlacek

File Name : SA94SA2M.WAV
Register: A

Sample Name : se94Sa2m MgF2SA
Solvent Name : Se94 SA 2 Mpuls
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off

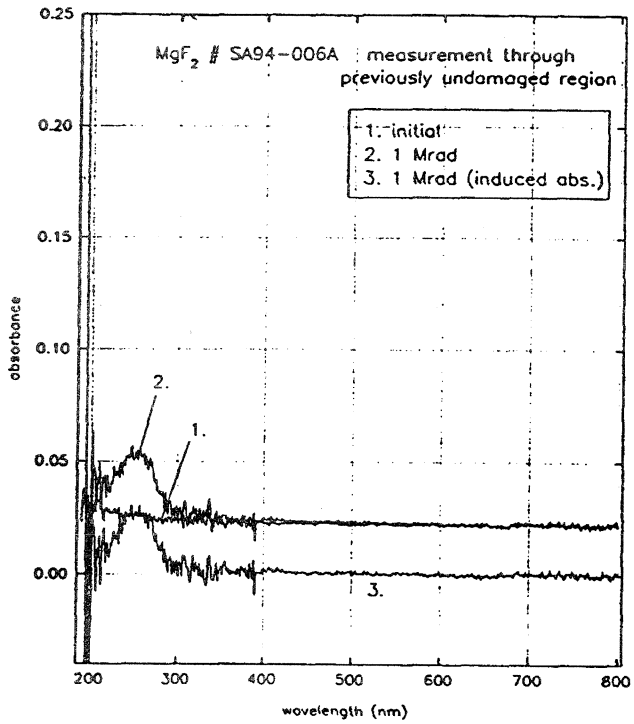


2 Mpulses

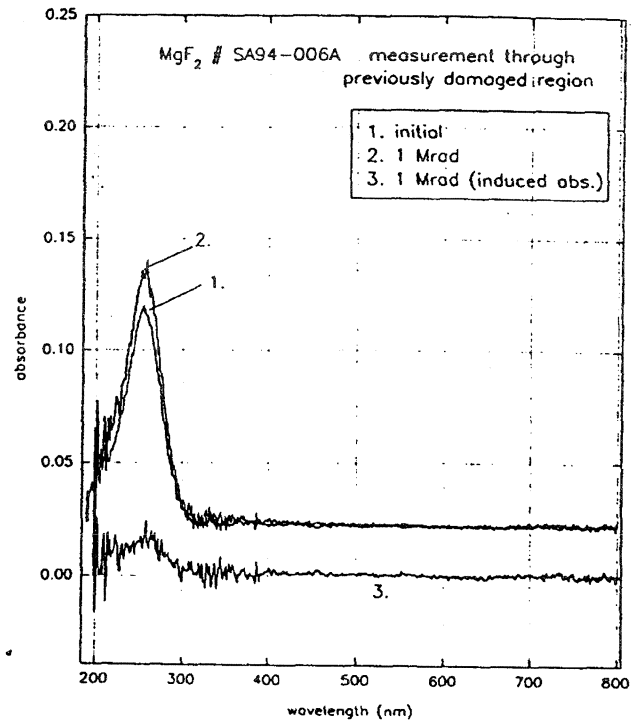
Marked Wavelengths
Reg A: L 192 - 0.00185
Reg A: L 194 - 0.00218 } 0.002
Reg A: L 256 - 0.02129 0.021
Reg A: L 318 - 0.00148
Reg A: L 804 - 0.00227 0.002

Δ193 nm = 0 /cm
Δ256 nm = 0.019/cm

MgF_2 06A



4-20-95



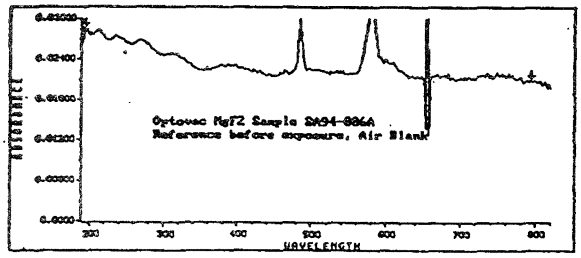
---> WAVELENGTH SCAN REPORT <---

Date : 05-29-1994
Time : 10:09:16
Operator : Jan Sedlacek

File Name : SA94GARF.WAV Register: A

Sample Name : sa94Garf MgF2GA
Solvent Name : SA94 GA ref bfE
Concentration : 0.0000
Units : Air Blk

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.02756
Reg A: L 194 - 0.02847
Reg A: L 794 - 0.02066

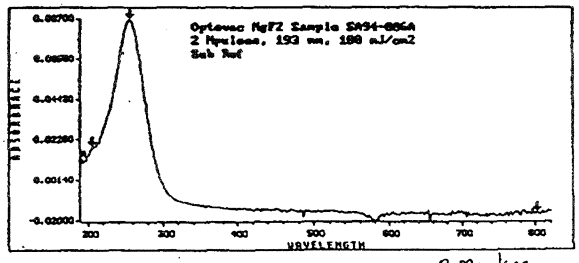
---> WAVELENGTH SCAN REPORT <---

Date : 05-29-1994
Time : 14:16:00
Operator : Jan Sedlacek

File Name : SA94GA2M.WAV Register: A

Sample Name : sa94Ga2m MgF2GA
Solvent Name : SA94 GA 2 Mpuls
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off

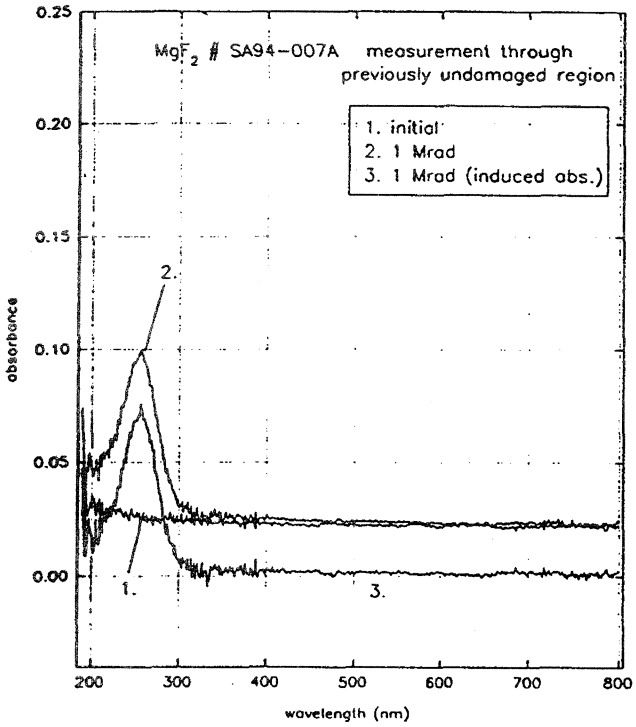


2 Mpulses

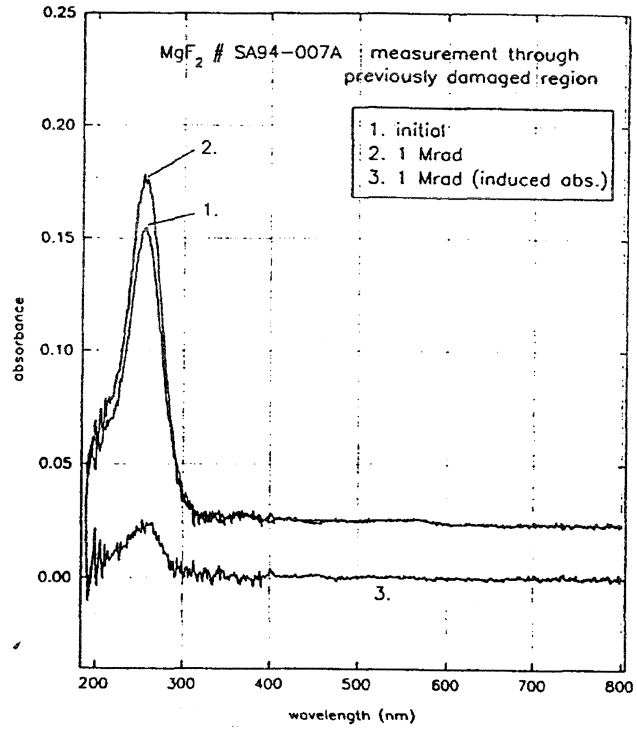
Marked Wavelengths
Reg A: L 192 - 0.01054 > 0.011
Reg A: L 194 - 0.01114
Reg A: L 206 - 0.01059
Reg A: L 256 - 0.00669 0.087
Reg A: L 802 - -0.01573 -0.016

Δ193nm = 0.027/cm
Δ256nm = 0.103/cm

MgF_2 07A



4-20-95



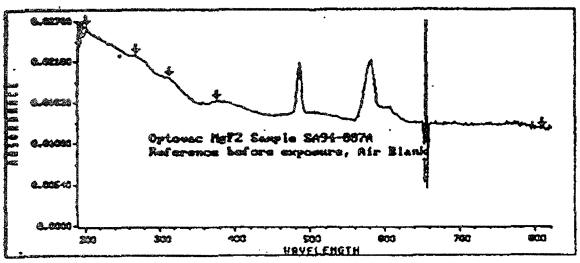
---> WAVELENGTH SCAN REPORT <---

Date : 06-06-1994
Time : 11:03:37
Operator : Jan Sedlacek

File Name : SA947ARF.WAV Register: A

Sample Name : sa947arf MgFZ7A
Solvent Name : SA94 7A Ref bfE
Concentration : 0.0000
Units : Air Blk

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.02444
Reg A: L 194 - 0.02556
Reg A: L 206 - 0.02634
Reg A: L 268 - 0.02248
Reg A: L 314 - 0.01952
Reg A: L 376 - 0.01646
Reg A: L 808 - 0.01276

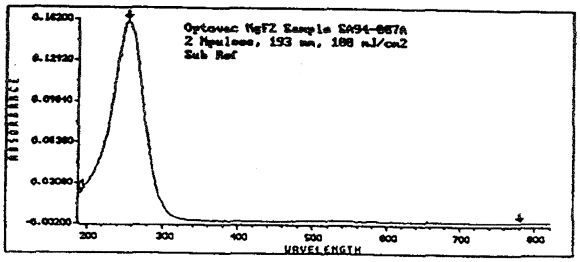
---> WAVELENGTH SCAN REPORT <---

Date : 06-06-1994
Time : 15:13:06
Operator : Jan Sedlacek

File Name : SA947A2M.WAV Register: A

Sample Name : sa947a2m MgFZ7A
Solvent Name : SA94 7A 2 Mpuls
Concentration : 100.00
Units : mJ SubRf

Function % : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off

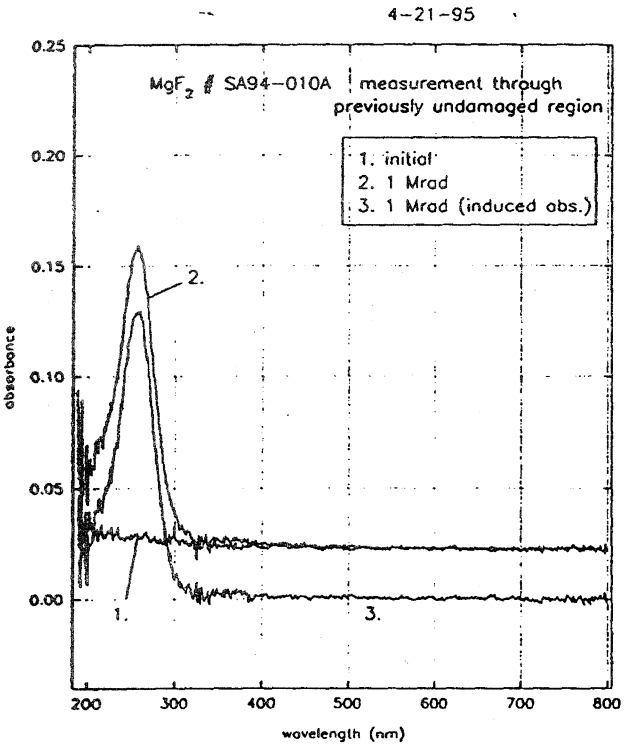


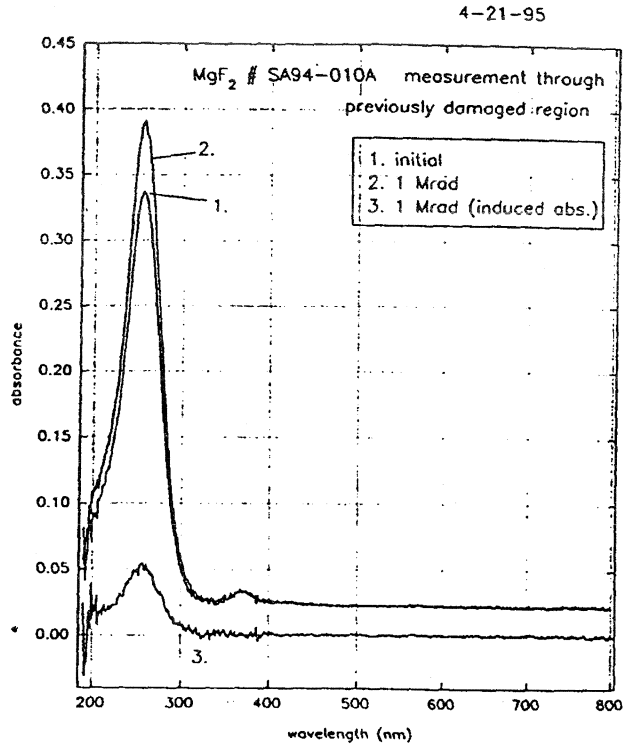
2 Mpulses

Marked Wavelengths
Reg A: L 192 - 0.02318 > 0.024
Reg A: L 194 - 0.02432
Reg A: L 256 - 0.16019 0.160
Reg A: L 782 - 2.1E-04 0.0002

Δ193nm = 0.024/cm
Δ256nm = 0.16/cm

MgF_2 10A





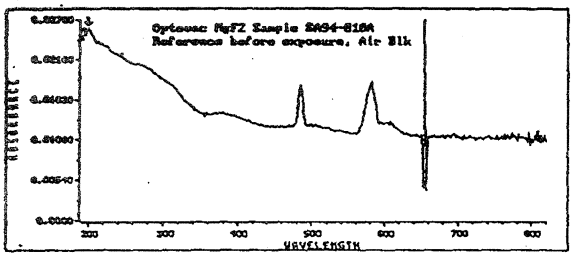
—> WAVELENGTH SCAN REPORT <—

Date : 06-07-1994
Time : 09:52:00
Operator : Jan Sedlacek

File Name : SA9410AR.WAV Register: A

Sample Name : aa9410ar MgFZ10
Solvent Name : SA94 10A RefbfE
Concentration : 0.0000
Units : Air Blk

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.02426
Reg A: L 194 - 0.02457
Reg A: L 200 - 0.02591
Reg A: L 800 - 0.01068

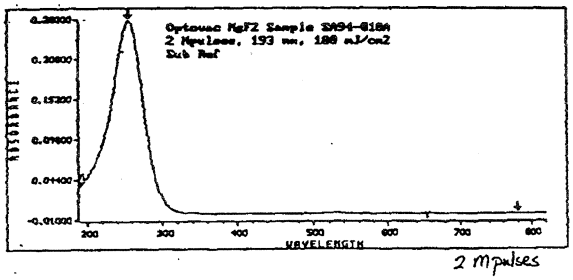
—> WAVELENGTH SCAN REPORT <—

Date : 06-07-1994
Time : 13:58:54
Operator : Jan Sedlacek

File Name : SA9410A2.WAV Register: A

Sample Name : aa9410a2 MgFZ10
Solvent Name : SA94 10A 2 Mpul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off

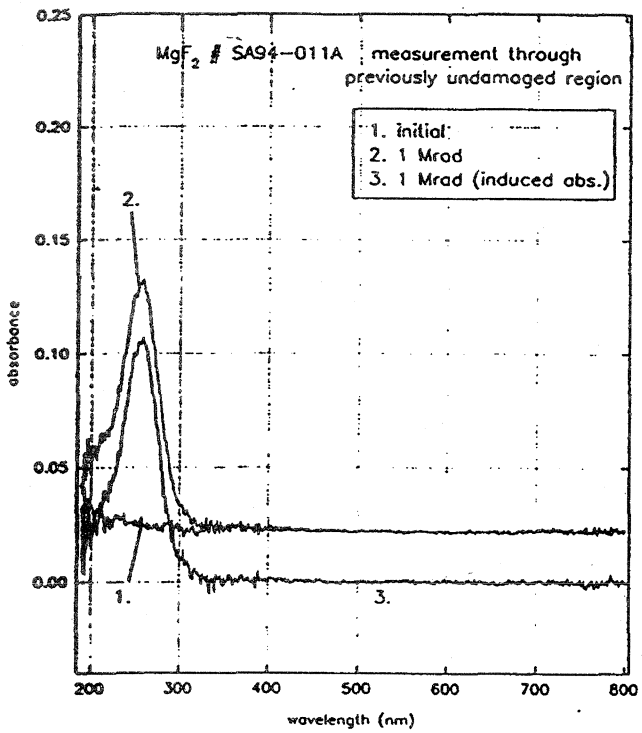


2 Mpulses

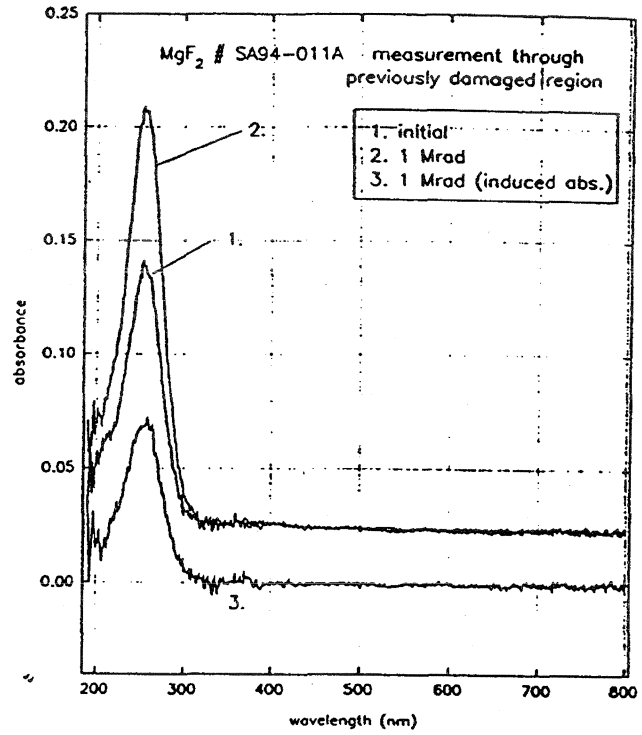
Marked Wavelengths
Reg A: L 192 - 0.03593 } 0.038
Reg A: L 194 - 0.03883
Reg A: L 256 - 0.25810 0.258
Reg A: L 700 - -9.0E-04 −0.001

Δ 193nm = 0.039/cm
Δ 256nm = 0.259/cm

MgF_2 11A



4-20-95



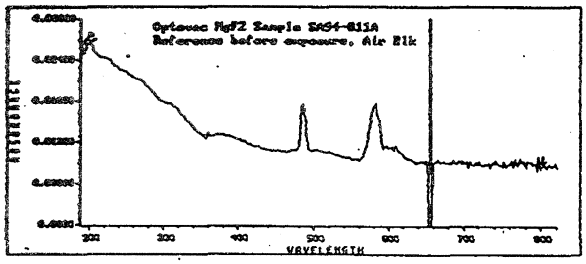
---> WAVELENGTH SCAN REPORT <---

Date : 06-08-1994
Time : 10:31:31
Operator : Jan Sedlacek

File Name : SA9411AR.WAV Register: A

Sample Name : sa9411ar MgF211
Solvent Name : SA94 11A RefBfE
Concentration : 0.0000
Units : Air Blk

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



Marked Wavelengths
Reg A: L 192 - 0.02481
Reg A: L 194 - 0.02547
Reg A: L 200 - 0.02641
Reg A: L 204 - 0.02632
Reg A: L 802 - 0.00845

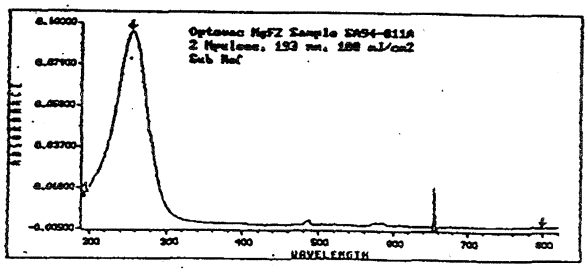
---> WAVELENGTH SCAN REPORT <---

Date : 06-08-1994
Time : 14:37:18
Operator : Jan Sedlacek

File Name : SA9411A2.WAV Register: A

Sample Name : sa9411a2 MgF211
Solvent Name : SA94 11A 2 Npul
Concentration : 100.00
Units : mJ SubRf

Function : Absorbance
Wavelength Range : 190 to 820 nm
Integration Time : 1 s
Std Deviation : Off



2 Mpulses

Marked Wavelengths
Reg A: L 192 - 0.01126 > 0.012
Reg A: L 194 - 0.01282
Reg A: L 254 - 0.09618 0.096
Reg A: L 800 - -0.00296 -0.003

Δ193nm = 0.015/cm
Δ254nm = 0.099/cm